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ABSTRACT

This document presents an updated national educational technology plan. Chapter 1 summarizes the goals set forth in the 1996 national educational technology plan and describes the Virtual High School Project. Chapter 2 addresses support for teacher use of technology, teacher and student access to technology, use of digital content and networked applications for teaching and learning, and technology's impact on teaching and learning. Chapter 3 discusses helping students to comprehend difficult-to-understand concepts, helping students to engage in learning, providing students with access to information and resources, better meeting students' individual needs, and looking forward. Chapter 4 covers the five national education technology goals: (1) all students and teachers will have access to information technology in their classrooms, schools, communities, and homes; (2) all teachers will use technology effectively to help students achieve high academic standards; (3) all students will have technology and information literacy skills; (4) research and evaluation will improve the next generation of technology applications for teaching and learning; and (5) digital content and networked applications will transform teaching and learning. Appendices include a description of the process of developing the plan, a list of contributors, and endnotes. An educational technology timeline of highlights during the Clinton Administration, 1993-2000, is also included. (Contains 66 references.) (MES)

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e-Learning

PUTTING A WORLD-CLASS EDUCATION AT THE FINGERTIPS OF ALL CHILDREN

ED 444 604

THE NATIONAL EDUCATIONAL TECHNOLOGY PLAN

U.S DEPARTMENT OF EDUCATION

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e-Learning

PUTTING A WORLD-CLASS EDUCATION AT THE FINGERTIPS OF ALL CHILDREN

THE NATIONAL EDUCATIONAL TECHNOLOGY PLAN

U.S. DEPARTMENT OF EDUCATION

Richard W. Riley
Secretary

Frank S. Holleman III
Deputy Secretary

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Director, Office of Educational Technology

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Educational Technology Timeline, Highlights During the Clinton Administration: 1993-2000

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December 2000

Dear Member of Congress:

In response to the tremendous potential for improving educational opportunities through the effective use of technology, I released the nation's first educational technology plan in 1996. That plan set forth a far-reaching vision for widespread improvements in teaching and learning guided by four national educational technology goals.

We have made remarkable progress toward achieving the 1996 educational technology goals. Due in large part to federal programs such as the Technology Literacy Challenge Fund and the E-rate program, many of the nation's teachers and students are beginning to reap the benefits of increased access to computers and the Internet. That progress is a testament to the commitment of local communities, states, the private and non-profit sectors, educators, the federal government, and others to integrate technology into America's schools.

Building on what has been accomplished, I am pleased to share with you *e-Learning: Putting a World-Class Education at the Fingertips of All Children*. This plan shows where progress has been made since 1996, where new opportunities exist, and where challenges remain. *e-Learning* outlines five new national educational technology goals. It proposes national, state, local, and private sector actions to ensure that all of our nation's teachers and students have the opportunity to take advantage of the power of new and emerging technologies for widespread improvements in teaching and learning—today, tomorrow, and far into the future.

Leadership is required to sustain our commitment to the future. I hope that the Congress and the new administration will continue to support state and local education leaders in using technology to strengthen the academic achievement of all children. National progress on these five goals is an opportunity that the country cannot afford to miss.

Yours sincerely,

Dick Riley

Richard W. Riley
Secretary, U.S. Department of Education

EXECUTIVE SUMMARY

In response to the educational opportunities made available by dramatic technological innovations in the early and mid-1990s, U.S. Secretary of Education Richard Riley released the nation's first educational technology plan in 1996, *Getting America's Students Ready for the 21st Century: Meeting the Technology Literacy Challenge*. This plan presented a far-reaching vision for the effective use of technology in elementary and secondary education to help the next generation of school children to be better educated and better prepared for the evolving demands of the new American economy.

Due in large part to markedly increased federal, state, local and private investment in technology for education, the nation has made tremendous progress toward achieving the 1996 national educational technology goals. These investments in computers and Internet access, professional development, technical support and content have allowed many elementary and secondary school teachers and students to reap the benefits of powerful teaching and learning applications.

The latest research and evaluation studies demonstrate that school improvement programs that employ technology for teaching and learning yield positive results for students and teachers. Given that many schools and classrooms have only recently gained access to technology for teaching and learning, the positive outcomes of these studies suggest a future for education that could be quite bright if the nation maintains its commitment to harnessing technology for education.

The adoption of new and emerging technologies by schools and classrooms offers even more reason to be hopeful. With sufficient access and support, teachers will be better able to help their students comprehend difficult-to-understand concepts and engage in learning, provide their students with access to information and resources, and better meet their students' individual needs. If we take advantage of the opportunities presented to us,technology will enhance learning and improve student achievement for *all* students.

Given the tremendous progress made in integrating technology into teaching and learning and the continued advances in the affordability and capabilities of technology, the need to move beyond the 1996 goals became evident. In the fall of 1999, the U.S. Department of Education undertook a strategic review and revision of the national educational technology plan, in consultation with the full range of stakeholders: educators, researchers, policymakers, students, parents, and higher education, industry and other leaders. The outcome of this strategic review was five new national goals for technology in education.

Working together to achieve these goals constitutes a major leadership imperative facing those seeking widespread improvements in teaching and learning. As a nation, we should pledge to meet these new goals:

NATIONAL EDUCATIONAL TECHNOLOGY GOALS

Goal 1: All students and teachers will have access to information technology in their classrooms, schools, communities and homes.

Goal 2: All teachers will use technology effectively to help students achieve high academic standards.

Goal 3: All students will have technology and information literacy skills.

Goal 4: Research and evaluation will improve the next generation of technology applications for teaching and learning.

Goal 5: Digital content and networked applications will transform teaching and learning.

"NEW TECHNOLOGIES CAN BE AN INCREDIBLE TOOL OF EMPOWERMENT IN SCHOOLS, HOMES, BUSINESSES, COMMUNITY CENTERS AND EVERY OTHER PART OF OUR CIVIC LIFE.…IMAGINE IF COMPUTERS AND INTERNET CONNECTIONS WERE AS COMMON IN EVERY COMMUNITY AS TELEPHONES ARE TODAY; IF ALL TEACHERS HAD THE SKILLS TO OPEN STUDENTS' EYES AND MINDS TO THE POSSIBILITIES OF NEW TECHNOLOGIES; IF EVERY SMALL BUSINESS IN EVERY RURAL TOWN COULD JOIN WORLDWIDE MARKETS ONCE RESERVED FOR THE MOST POWERFUL CORPORATIONS—JUST IMAGINE WHAT AMERICA COULD BE."

PRESIDENT CLINTON

In committing to achieve these goals, everyone has a role to play: federal, state and local governments; education; nonprofit organizations and associations; the private sector; communities; and families. For each of these goals, there are numerous strategies that can be undertaken to ensure continued progress in using technology effectively for education.

Goal 1: All students and teachers will have access to information technology in their classrooms, schools, communities and homes.

An integral part of school improvement and reform efforts in the 21st century, in the United States and abroad, will be student and teacher access to educational technology, such as computers connected to the Internet. Universal access to the Internet will help end the isolation of teachers; exponentially expand the resources for teaching and learning in schools and classrooms; provide more challenging, authentic and higher-order learning experiences for students; and make schools and teachers more accountable to parents and communities.

The quality of Internet access is critical. Broadband access will be the new standard. Slow, unreliable connections that cannot support interactivity or rich multimedia content will no longer be sufficient. To take advantage of access to technology for improved teaching and learning, it will become increasingly important to build and support network infrastructures—wired or wireless, desktop or handheld—that allow multiple devices to connect simultaneously to the Internet throughout every school building and community in the nation.

To realize the goal of universal access to educational technology for students and teachers, we should ensure sustained and predictable funding for technology; ensure that technology plans reflect the educational

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needs of students and are regularly updated; improve the affordability, reliability and ease of use of educational technology; ensure that school buildings and facilities are modern; strengthen our commitment to eliminating the digital divide; and ensure that all students have equal opportunities to access and use technology.

Goal 2: All teachers will use technology effectively to help students achieve high academic standards.

Most teachers have been prepared for a model of teaching dramatically out of step with what is needed to prepare the nation's students for the challenges they will face in the future. Recent reports by the American Council on Education, the CEO Forum on Education and Technology, the Milken Exchange on Education Technology, the National Commission on Mathematics and Science Teaching for the 21st Century, and the National Council for Accreditation of Teacher Education, among others, all identify opportunities to enhance teacher quality and teacher preparation, particularly as they relate to the effective use of technology in education.

Ensuring that the nation has effective 21st-century teachers requires more than just providing sufficient access to technology for teaching and learning. We should improve the preparation of new teachers, including their knowledge of how to use technology for effective teaching and learning; increase the quantity, quality and coherence of technology-focused activities aimed at the professional development of teachers; and, improve the instructional support available to teachers who use technology.

Goal 3: All students will have technology and information literacy skills.

The need to prepare students with the skills they need to participate fully in our increasingly technological society has become a major priority for the nation. A meaningful, unified approach to providing students with the skills they will need for their futures must be more than a checklist of isolated technology skills; rather, these skills are only a first step in assuring all our children become proficient information and technology users.

Also necessary are information problem-solving skills, such as how to define tasks, identify information seeking strategies, locate and access information, determine information's relevance, organize and communicate the results of the information problem-solving effort and evaluate the effectiveness and efficiency of the solution. The call for this new "21st-century literacy" in no way supplants current efforts by states and districts to set and even raise academic standards for students; it simply reflects the fact that the bar for an educated citizenry and workforce continues to rise to reflect changes in society.

In requiring these skills of students, we will ensure that the opportunities made possible through the use of technology will be available to all students as they progress through school, regardless of personal or socioeconomic factors. Even for those students who do not pursue technology careers, ensuring technology and information literacy skills will provide a number of benefits.

To ensure that students are prepared for their future we should: include technology and information literacy in state and local standards for what students should know and be able to do; ensure students use technology appropriately and responsibly; develop new student assessment tools; and strengthen partnerships with industry to help meet the workforce needs of the future.

Goal 4: Research and evaluation will improve the next generation of technology applications for teaching and learning.

At the dawn of the 21st century, we are still at the beginnings of a technological revolution that is bringing dramatic changes to our society. This technological revolution will not automatically translate into a similar revolution in teaching and learning. While we have learned a tremendous amount about the implementation and use of technologies for teaching and learning in the past few years, the need for an expanded, ongoing national research and evaluation program to improve the next generation of technology applications for teaching and learning is profound.

To implement such a program requires a sustained, multi-disciplinary collaboration of learning scientists, technologists, and subject-matter experts. Numerous

organizations have pointed out the urgency of this national need, including the President's Committee of Advisors on Science and Technology, the U.S. Department of Education, the National Science Foundation, the National Research Council, private charitable foundations, independent research institutes and representatives of academia.

To ensure that research and evaluation will improve the next generation of technology applications for teaching and learning, we should: initiate a systematic agenda of research and evaluation on technology applications for teaching and learning; encourage state and local evaluations of technology programs; and support the dissemination and use of research-based information to improve teaching and learning.

Goal 5: Digital content and networked applications will transform teaching and learning.

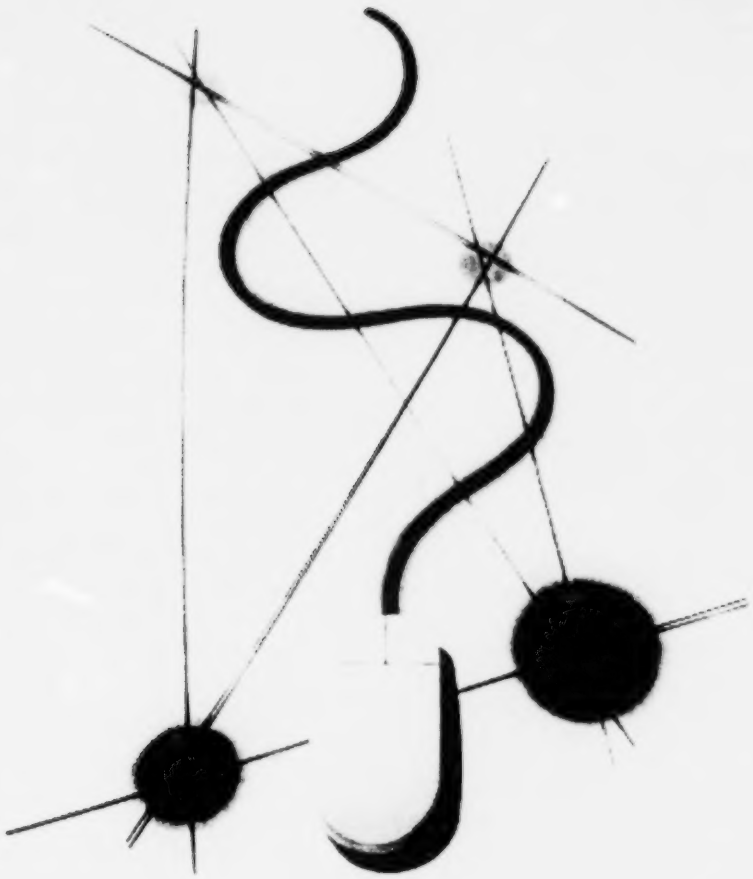
Digital content and networked applications will support transformative changes in our approaches to teaching and learning. In order for these changes to lead to increased educational opportunities for all students, digital content and networked applications must be independently judged to be of high quality (both in terms of grounding in learning science and pedagogical effectiveness), well-documented, comprehensive and available for all grades and subject areas, and have the power to inspire or motivate students. In addition, they must be easy to find and access, easy for students and teachers to use, and accessible to people with disabilities.

Today, there exists tremendous opportunities for the creation of powerful digital content and networked applications. For instance, digital content and networked applications offer direct opportunities to enhance learning by helping students to comprehend difficult-to-understand concepts; helping students to engage in learning; providing students with access to information and resources; and better meeting students' individual needs. In addition, technology applications can increase parental involvement and improve the accountability and efficiency of school administration.

To ensure that digital content and networked applications will transform teaching and learning, we should: ensure administrators and policymakers are technologically literate; support efforts to increase our understanding of how to improve teaching and learning through partnerships within and across sectors; identify leadership opportunities provided by technology to offer better ways of accomplishing educational goals; continue and expand efforts to digitize rich educational materials consistent with copyright laws; encourage the aggregation of demand for resources and services to attract better and more effective technology-based services for teaching and learning; support educators and technologists in defining what digital content and networked applications should be available to support teaching and learning; remove barriers to purchasing digital content and networked applications; recognize developers of high-quality digital content and networked applications and exemplary adoption of educational technologies; and support the integration of digital content and networked applications into state and local standards and curricular frameworks.

THE LEADERSHIP IMPERATIVE

The use of technology in education must remain a national priority. It must be at the core of the educational experience, not at the periphery. Now is the time to renew our commitment to the future by challenging the nation to take bold action in hastening the coming of the future of education. The leadership imperative is clear. Collectively, these new goals for technology in education represent an updated, high-level strategy for ensuring that all students will benefit from enhanced learning opportunities afforded by new and emerging communications and information technologies.



CHAPTER 1

INTRODUCTION

"EVERY CHILD IN AMERICA DESERVES A 21st CENTURY EDUCATION AND ACCESS TO 21st CENTURY TECHNOLOGY."

VICE PRESIDENT AL GORE

In response to the educational opportunities made available by dramatic technological innovations in the early and mid-1990s, U.S. Secretary of Education Richard Riley released the nation's first educational technology plan in 1996, *Getting America's Students Ready for the 21st Century: Meeting the Technology Literacy Challenge*.[1] To help the next generation of school children to be better educated and better prepared for the evolving demands of the new American economy, the 1996 plan presented a far-reaching vision for the effective use of technology in elementary and secondary education. The plan reflected four national educational technology goals set forth by President Clinton and Vice President Gore:

- All teachers in the nation will have the training and support they need to help students learn using computers and the information superhighway.
- All teachers and students will have access to modern multimedia computers in their classrooms.
- Every classroom will be connected to the information superhighway.
- Effective software and online learning resources will be an integral part of every school's curriculum.

The 1996 national educational technology plan provided the nation with a blueprint for the widespread, effective use of technology in education.

Due in large part to markedly increased federal, state, local and private investment in technology for education, the nation has made tremendous progress toward achieving the national educational technology goals first laid out in 1996. These investments in computers, Internet access, professional development, technical support and content have allowed many elementary and secondary school teachers and students to reap the benefits of increased access to powerful teaching and learning applications. With emerging evidence of effective uses of technology in education,[2] there is far-reaching public support for the increased use of technology in elementary and secondary education:[3]

- 69 percent of Americans believe that the use of computer technology has improved the quality of instruction in their locals schools; and
- 82 percent believe that schools should invest more in computer technology for instructional purposes.

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Net Courses for High School

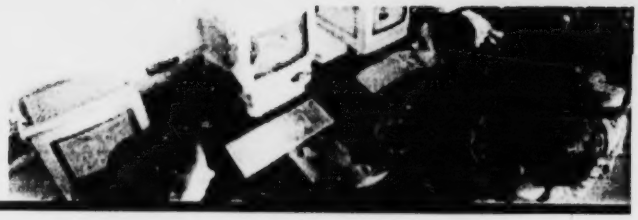
The Virtual High School (VHS)- supported by a federal technology innovation Challenge Grant- is a consortium of high schools that offers network-based courses (NetCourses) taught by consortium teachers for students in consortium schools. Teachers in the VHS pool, with the help of experienced facilitators, design and offer NetCourses over the Internet. Each VHS school also provides a part-time coordinator who acts as liaison among students, the VHS teachers, and the central VHS administrative staff.

The growth of Virtual High School is impressive. In September 1997, VHS offered Internet-based courses for the first time to about 500 students in 27 schools in ten states. By May 2000, after six semesters of operation, VHS offered 87 different courses to about 1,700 students in 112 schools located in 29 states. The number of students enrolled and the average number of students per NetCourse have been steadily increasing. The NetCourses, which are often quite challenging, include topics like economics, Shakespearean literature, nuclear physics, world conflict and peacemaking, and various languages of computer programming.

The Virtual High School often serves students who would not have access to such a variety of courses. Small school size and remote location often limit access to adequately trained instructors to teach a varied and sometimes specialized selection of courses. In fact, statistics show that over 80 percent of the schools participating in VHS have enrollments of fewer than 1,500 students. Half of these schools have fewer than 800 students. As VHS has developed, some of these small schools have come up with creative ways to get involved in VHS, and VHS has supported them in order to make their participation possible. In some cases whole districts and geographic regions have organized into "sub-cooperatives," pooling their local resources to take advantage of VHS courses. The bottom line is that instead of schools finding an expensive solution, or no solution at all, to the challenges that many schools face in meeting the demands for course offerings, they are able to work with VHS to develop creative solutions- all without hiring new staff or adding a new building.

The principal of Monroe Senior High School, a very small school (the smallest K-12 school in Alabama) located in rural Southwest Alabama with a total enrollment of 110 students- grades K-12- has high praises for their participation in VHS. She feels that had it not been for VHS, their school would not have ranked in the 60th percentile on the Stanford-nine test, nor would it have had 99 percent of its juniors (Class of 2001) to pass all required parts of the new state exit exam. Monroe hopes to be able to acquire more computers in the near future so that they can accommodate more students in the program. Right now, because of the wide range of interest in VHS, they have more students than space.

School principals and others at participating VHS schools had reported that they believe the courses to be of high quality. A recent evaluation of VHS conducted by SRI International confirmed that VHS courses provide students with high-quality curriculum content.



"ONE OF THE MOST EXCITING THINGS I USE THE INTERNET FOR IS GETTING UP-TO-DATE NEWS ACROSS THE WORLD. I DID A THESIS PAPER LAST YEAR ON CHINA AND I WAS ABLE TO USE NEWSPAPERS FROM HONG KONG AS RESEARCH. IT WOULD HAVE BEEN IMPOSSIBLE TO GET SUCH NEW INFORMATION FROM THOSE SOURCES USING CONVENTIONAL METHODS."

-STUDENT, INTERNET CHAT WITH U.S. DEPARTMENT OF EDUCATION

With increased access to technology in schools and classrooms and with public support for its use, we can now look to a future where the Internet and other emerging information technologies have the potential to foster even more dramatic improvements in education. We have the potential to create an educational system enhanced by technology that could be better suited to the needs of educators, students and their families. Indeed, visionary school leaders foresee advances in our understanding of what learning really is, how diversified it is, and which methods are flexible enough to meet the learning needs of *all* students.[1]

For us to realize these visions, technology in education must remain a national priority. It must be at the core of the educational experience, not at the periphery. Indeed, emerging technologies will allow us to develop new content to address evolving conceptions of the skills and knowledge needed to succeed in today's global society. Technology will enable new teaching strategies and tools to increase student acquisition of necessary skills and knowledge. It will also offer dramatic improvements in how we measure student progress in attaining the necessary skills and knowledge. If technology is to achieve genuinely transforming improvements in schooling for all students, it must be at the center of school reform and improvement efforts.

The leadership imperative is clear. Now is the time for us to renew our commitment to the future of education. This report will show where progress has been made, where new opportunities exist, and where challenges remain. Most important, it proposes national, state and local actions that will ensure that all of our nation's teachers and students will have the opportunity to take advantage of the power of new and emerging technologies for widespread improvements in teaching and learning today, tomorrow and far into the future.

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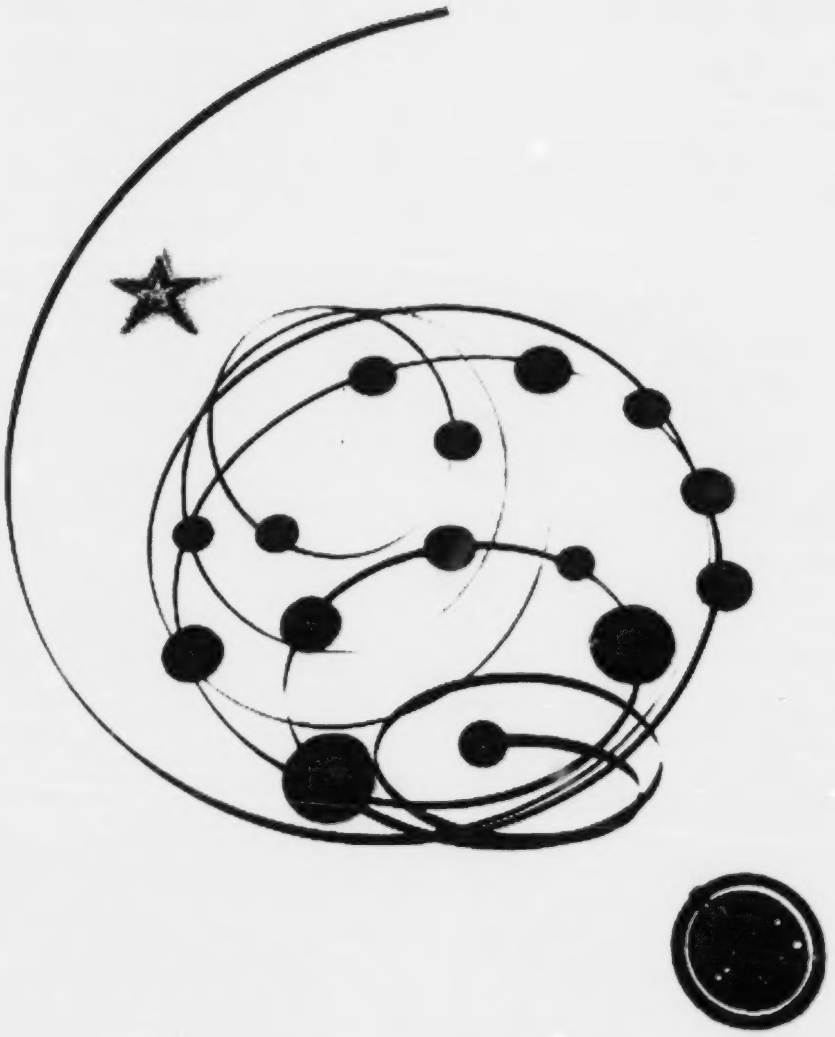


CHAPTER 2

TEACHING AND LEARNING WITH TECHNOLOGY: PROGRESS AND PROSPECTS

"TO IMPROVE THE RETURN ON AMERICA'S EDUCATIONAL TECHNOLOGY INVESTMENT, WE MUST PROVIDE TEACHERS WITH THE SKILLS NECESSARY TO INTEGRATE TECHNOLOGY EFFECTIVELY INTO THE CURRICULUM. WE NEED TO USE TECHNOLOGY TO CONNECT SCHOOLS, FAMILIES, AND THE COMMUNITY AND PROVIDE RESOURCES FOR SCHOOLS TO USE TECHNOLOGY MORE EFFECTIVELY."

-CRAIG BARRETT, PRESIDENT AND CEO, INTEL CORPORATION

The 1996 national educational technology goals were the four pillars of a comprehensive strategy for realizing large-scale improvements in teaching and learning. Addressing issues of support for teacher use of technology, teacher and student access to technology (computers and connectivity), and use of digital content and resources, achieving the national educational technology goals was intended to support widespread improvements in student achievement. This chapter reviews the nation's progress on each of these fronts, concluding with a summary of the emerging positive impact of the nation's educational technology investments.

SUPPORT FOR TEACHER USE OF TECHNOLOGY

Preparing the roughly three million teachers at work in our public schools to use technology effectively first became a priority in the early 1990s.[4] In the 1993-94 school year, only 14 percent of public school teachers had more than eight hours of training in the area of educational technology, and as many as 50 percent of teachers had little or no experience at all with technology in the classroom.[5] In addition, most graduates from teacher preparation institutions had only limited knowledge of the ways technology could be used in their professional practice.[6]

By 1999, one-third of public elementary and secondary school teachers reported feeling well or very well prepared to use computers and the Internet for classroom instruction.[8] In addition, the vast majority of teachers in 1999 reported that professional development training in basic uses of technology for instruction were now available to them, and nearly half of all teachers had spent more than eight hours in educational technology-related professional development over the previous three years.[9] As a demonstration of the impact of technology-related professional development, teachers with more professional development in the use of computers or the Internet over the prior three years were more likely to assign students various types of work involving technology.[10]

Even in schools with sufficient access to modern computers, the Internet and digital content, teachers still face challenges to using technology effectively. Among the issues facing teachers' effective use of computers and the Internet are a lack of the following: release time to learn, practice and plan ways to use computers or the Internet (cited by 83 percent of public

elementary and secondary school teachers); support for integrating telecommunications into the curriculum (68 percent of teachers); training opportunities (66 percent of teachers); technical support or advice (64 percent of teachers); and administrative support (43 percent of teachers).[11] Strikingly, one estimate of technical support responsiveness by district technology coordinators in 27 states reveals that on average it takes between 14 hours and more than seven days to fix a technology problem that arises in a school or classroom (the average response time across all 27 states was over two days).[12]

New teachers entering the profession are still not being adequately prepared to teach with technology. The CEO Forum on Education and Technology recently found that fewer than half of the nation's teacher preparation institutions require students to design and deliver instruction using technology, and that even fewer require technology use in the student teaching experience.[13] In response, the CEO Forum on Education and Technology prepared the Teacher Preparation School Technology and Readiness (StaR) chart, a self-assessment tool for colleges of education. The STaR chart provides teacher preparation programs with a set of benchmarks they can use to measure their progress in integrating technology into their programs.[14] As of November 2000, 243 teacher preparation institutions had committed to using this self-assessment tool to help ensure that every new teacher graduates from their institution prepared to use and integrate technology effectively into teaching and learning.[15]

TEACHER LED TECHNOLOGY CHALLENGE
BERKELEY UNITED SCHOOL DISTRICT, CALIFORNIA

A Model that Celebrates Good Teaching

As evidenced by their motto- "*It's not about technology. It's about LEARNING*" - the Teacher Led Technology Challenge (TLTC) strives to provide all regular pre-K through eighth-grade classroom teachers in Berkeley with the tools, support, and professional development they need to make computers and other technologies tools for teaching and learning in their classrooms. Berkeley teachers learn how to regularly integrate multimedia instructional materials in core subjects like reading, mathematics, science and writing; address the neglected learning styles and needs of students who learn differently; and harness technology tools to reach instructional goals recommended by national curriculum standards groups.

TLTC uses several innovative approaches to achieve these measures. First, TLTC helps regular classroom teachers in each school become leaders in integrating technology within their own building in a peer-to-peer support mode. Specifically, incremental, three-stage implementation allows teachers with various technology backgrounds to join the project when it is most comfortable for them. By developing the skills of "lead teachers" in each school, TLTC creates a corps of internal curriculum integration consultants and technical experts who can help teachers find the right technologies to integrate into a specific unit or topic and to troubleshoot any problems. Furthermore, a roving substitute teacher covers each teacher's classroom for an hour during the school day while three to five teachers are consecutively released from their class duties to meet individually, at their school site, with a Classroom Technology Integration Specialist in a program called "Prep Shop." The specialist and teacher discuss curriculum, outline instruction priorities, and together plan an activity to integrate computer technology. The specialist returns on subsequent days to each teacher's class to co-lead the planned activity with the teacher. These internal supports will sustain technology integration beyond the life of the Technology Innovation Challenge grant.

To help future teachers become proficient in the use of modern learning technologies, the U.S. Department of Education's Preparing Tomorrow's Teachers to Use Technology (PT3) program was created. Implementation and catalyst grants awarded under this initiative support program innovations developed by consortia of higher education institutions, state agencies, school districts, non-profit organizations and others who are joining forces to transform teacher preparation programs into 21st-century learning environments. To date, the PT3 program has committed to supporting 600,000 teachers to become technology-proficient by 2003. In fiscal year 2001, the administration has requested $150 million for this program to serve another 400,000 educators, bringing the total number reached by PT3 grants to one million by the year 2004. These grants will support teacher preparation improvements in virtually every state and region in the country, and a majority of the grants focus on improving technology use in low-income communities and rural areas, and among minority groups and special populations. Importantly, consortia participating in the program match federal dollars on at least an equal basis with cash or in-kind, fairly valued, services, supplies or equipment.

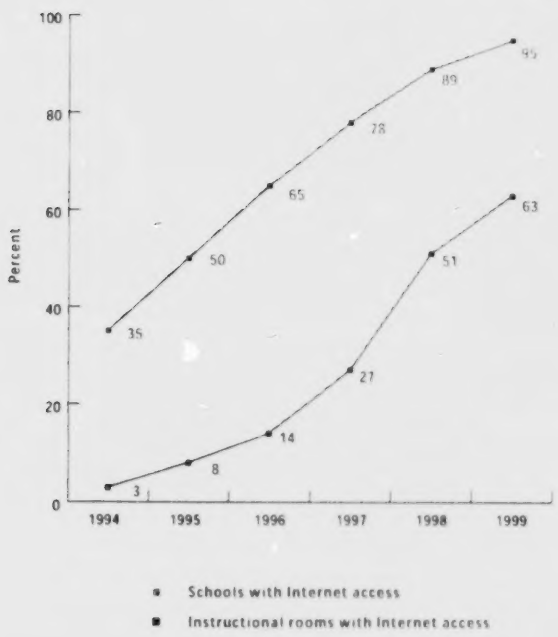
TEACHER AND STUDENT ACCESS TO TECHNOLOGY

Significant attention has been paid to making the strategic investments necessary to build an education technology infrastructure. Indeed, trends indicate that access has dramatically improved since the early 1990s. Due in large part to the successes of the Technology Literacy Challenge Fund, which provides resources to help states and districts develop and implement plans to achieve the 1996 national technology goals, and the E-Rate program, which provides discounts on telecommunications services to schools and libraries, by 1999 nearly every school in the nation could boast of being able to connect to the Internet and of being able to provide its teachers and students with access to computers and the Internet somewhere in the school.[16]

In 1994—the first year in which the National Center for Education Statistics (NCES) began systematically collecting data on the availability of technology in elementary and secondary schools—only 35 percent of public elementary and secondary schools and 3 percent of public school classrooms had access to the Internet. By 1999, access had increased by 60 percent: 95 percent of schools and 63 percent of classrooms had access to the Internet, providing on average one instructional computer with an Internet connection for every nine students.[17]

FIGURE 1. DRAMATIC INCREASES IN SCHOOL CONNECTIVITY SINCE 1994

Percent of Public Schools and Instructional Rooms with Internet Access: 1994 to 1999



Source: U.S. Department of Education, National Center for Education Statistics (2000). *Internet Access in U.S. Public Schools and Classrooms: 1994-1999*. NCES 2000-086, by Catrina Williams. Washington, D.C.
http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2000086

Over this time, the speed and capacity of connections to the Internet have also improved in most public schools. In 1996, relatively slow dial-up network connections were used by almost three-quarters of public schools with Internet access. By 1999, 86 percent of public schools connected via higher-speed and higher-capacity dedicated lines or through other types of high-speed connections (such as ISDN, cable modems and wireless connections).[16]

The pace of these changes is a testament to the commitment of local communities, states, the private sector, educators, the federal government and others to the integration of technology into America's schools. Both the Technology Literacy Challenge Fund and the E-rate program have been instrumental in leveraging other public and private resources to increase access to technology for our nation's students and teachers.

Access to computers and the Internet has also dramatically improved outside of school, in places such as community centers, libraries and homes. Programs such as the Community Technology Center Program have increased the availability of technology learning centers in public housing facilities, community centers, libraries and other educational facilities in low-income communities. Students who visit these centers use computers to get information from the Internet, send and receive e-mail, set up Web pages, receive tutoring and homework help, and carry out their own self-directed projects.[17] Similarly, the 21st Century Community Learning Center Program, which enables school districts to fund public schools as community education centers, provides opportunities for students to access technology after school hours.

"THIS E-RATE IS ABSOLUTELY ESSENTIAL IN ORDER TO HELP COMMUNITIES AND SCHOOLS ALL OVER THIS COUNTRY TO WIRE UP THEIR CLASSROOMS AND SCHOOLS. IT IS FOR THE FUTURE OF THIS COUNTRY. [WITHOUT THE E-RATE,] WE WILL END UP BEING A HAVE AND HAVE-NOT COUNTRY WHEN IT COMES TO EDUCATIONAL TECHNOLOGY AND WE CAN'T HAVE THAT."

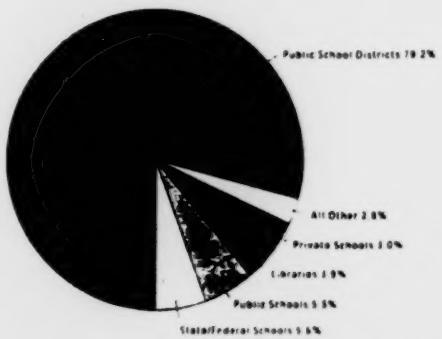
- U.S. SENATOR OLYMPIA J. SNOWE

Bridging the Digital Divide

The Education rate (E-rate) program, created under the Telecommunications Act of 1996, is in its fourth year of providing financial support to schools and libraries for Internet access and other telecommunications services. The recent evaluation of the program, *E-Rate and the Digital Divide: A Preliminary Analysis from the Integrated Studies of Educational Technology,** confirms that the program is operating as intended, increasing the acquisition of equipment and services for building connections, telecommunications services and Internet access. Thus far, more than $5 billion has been committed to public school districts, public and private schools, public libraries, states and consortia since the first wave of E-rate commitments in November 1998.

Over one million classrooms have been wired through the E-rate program. Most of the funding has gone to public schools, with the majority going to high-poverty districts. Schools with more than half of students eligible for free and reduced-price lunch represent only 25 percent of public school students; however, they have received over 60 percent of E-rate funds awarded. Because of the effort to serve the poorest students, those districts receive almost 10 times the E-rate funding per student when compared to the wealthiest districts. The targeting provisions of the program to the neediest schools and rural schools also are working. Three-quarters of all rural districts and districts with 75 percent or more students eligible for free and reduced-price lunch applied for the program in its second year- up for both groups from year one.

E-RATE FUNDING BY TYPE OF ENTITY

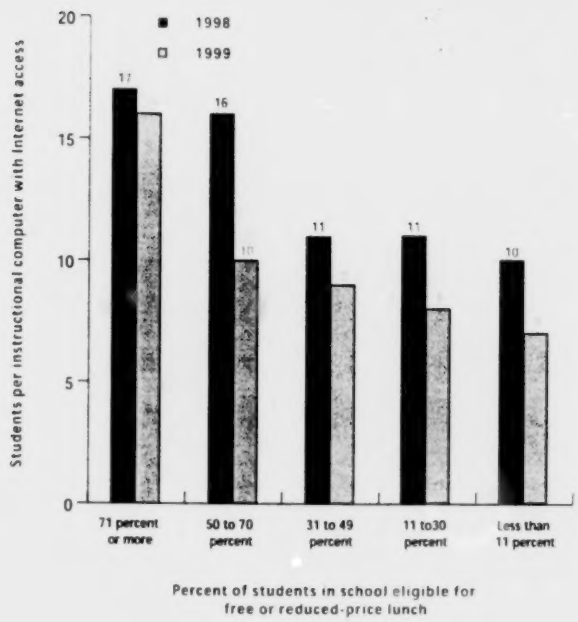


In addition to providing support to schools and libraries, the E-rate program is on the cutting edge of fast and efficient data collection. The program encourages electronic application submission and conducts ongoing electronic program monitoring and support by employing an electronic record system. The current data collection system, which contains approximately one million records with data as current as January 2000, was analyzed for the *E-Rate and the Digital Divide* report. Such an evaluation of an ongoing policy initiative is possible solely because of technology, and allows for the timely dissemination of research on the impact of the program.

* U.S. Department of Education, Planning and Evaluation Service and Office of Educational Technology, E-Rate and the Digital Divide: A Preliminary Analysis from the Integrated Studies of Educational Technology, 2000, Doc. # 00-17, prepared by Michael J. Puma, Duncan D. Chaplin, and Andreas D. Pape, The Urban Institute, Washington, D.C., 2000.

FIGURE 2. THE DIGITAL DIVIDE IN SCHOOL ACCESS TO TECHNOLOGY

Students per Instructional Computer with Internet Access, by School Poverty: 1998-1999



Source: U.S. Department of Education, National Center for Education Statistics (2000). *Internet Access in U.S. Public Schools and Classrooms, 1994-1999*. NCES 2000-086, by Catrina Williams. Washington, D.C.
http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2000086

Despite these great strides, there is more the nation needs to do to improve access and connectivity. For instance, teachers still cite access-related concerns regarding the use of technology in instruction: more than three-quarters of teachers cite a lack of computers in schools as a concern; nearly two-thirds cite "outdated, incompatible or unreliable" computers; and nearly six in ten cite the fact that "Internet access is not easily accessible."[20]

Only 10 percent of teachers have more than five computers in their classrooms[21]— the number of computers that would allow for the student-to-computer ratio advocated by the President's Committee of Advisors on Science and Technology.[22] And of those teachers with a computer in their classroom, one-third do not have a connection to the Internet.[23] While improvements have been made in recent years, the bandwidth available in most schools to connect to the Internet also remains quite limited—allowing only about one in every four computers in any given school to connect to the Internet simultaneously with other computers in the school.[24]

While progress has been made in bridging the "digital divide"—that is, the socioeconomic and racial/ethnic gap in access to computers and the Internet—challenges remain. For example, data reveal that students in poorer schools continue to have less access to computers and the Internet. In 1999, the ratio of students per instructional computer was 16 to 1 for the poorest schools in the United States, while our nation's richest schools averaged seven students per computer. In addition, Internet access in classrooms was also less likely in the poorest schools, with 39 percent connected. In contrast, three-fourths of the classrooms in wealthier schools were connected.[25]

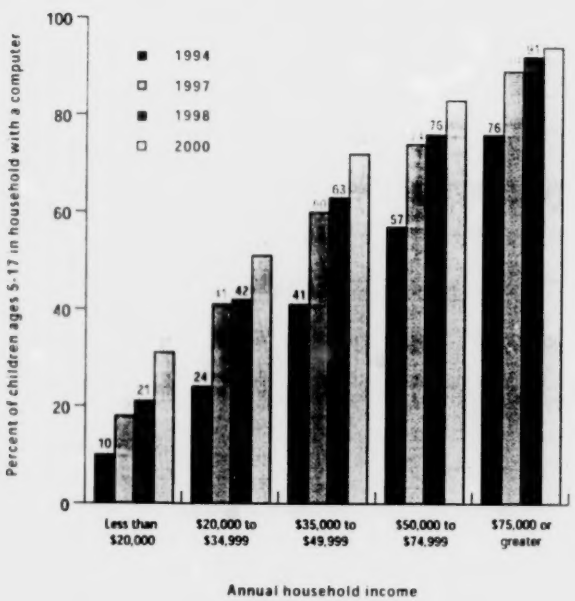
"I THINK THAT SOMETIMES TEACHERS ASSUME THAT EVERYONE HAS COMPUTERS, AND SOMETIMES THOSE KIDS ARE PUT AT A DISADVANTAGE. THEY HAVE TO COME IN AFTER SCHOOL AND MISS OUT ON ACTIVITIES SOMETIMES, BECAUSE 'THEY CAN'T GET ON IT ANY OTHER TIME."

-STUDENT, INTERNET CHAT WITH U.S. DEPARTMENT OF EDUCATION

The disadvantages of inequitable access to technology in schools and classrooms are compounded by the fact that students with limited access to technology in school are also less likely to have access to computers and the Internet at home. Although the percentage of homes with computers has increased in recent years, household income clearly determines the likelihood of student access at home. Ninety-four percent of school-aged children in families with household incomes of $75,000 or greater have computers in their homes this year (2000), while only 31 percent of students in families with household incomes less than $20,000 have them. Household income factors into student use of the Internet at home as well. Most households in the wealthiest income bracket have a family member who uses the Internet at home (85 percent), while only 18 percent of the poorest households with children use it at home.[8]

FIGURE 3. THE DIGITAL DIVIDE IN HOME ACCESS TO TECHNOLOGY

Percent of Children Living in a Household with a Computer, by Household Income: Selected Years



Source: U.S. Census Bureau, Current Population Survey, November 1994, October 1997, December 1998, and August 2000.

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USE OF DIGITAL CONTENT AND NETWORKED APPLICATIONS FOR TEACHING AND LEARNING

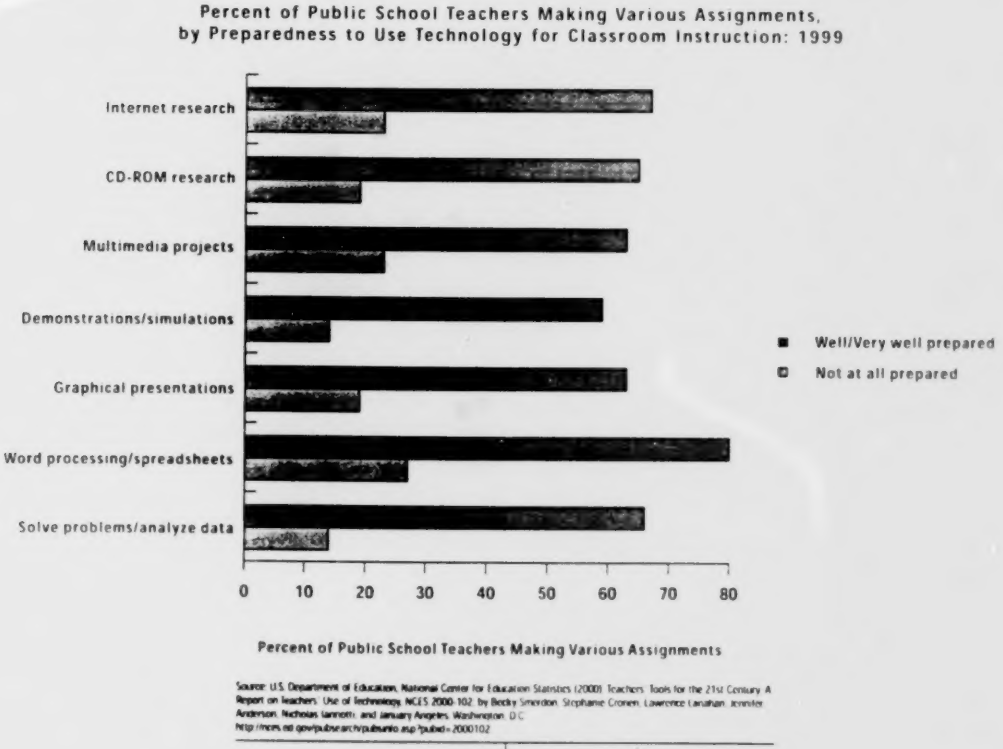
By the early 1990s, the market for digital content and educational software, built on outmoded premises about learning, was widely criticized for producing low-quality products or none at all for many content areas and grade levels—especially for middle and secondary school students.[27] In fact, in 1996, many teachers did not have ready access to computers and the Internet in their schools, and those that did often used technology only to provide supplemental drill and practice opportunities to their students.

Due to dramatic increases in the availability of computers and Internet access and to an increased emphasis on professional development, a majority of the nation's public elementary and secondary school teachers (53 percent) were employing digital content and networked applications in their classrooms at least to a small extent by 1999. Many of these same teachers (48 percent) also reported making instructional assignments to students outside the classroom.[28] The most common types of work assigned by teachers include: word processing/spreadsheets, Internet research, solving problems/analyzing data, and drills.[29] In fact, teachers who report feeling well prepared to use technology use it more frequently, use it in a greater variety of ways individually and with their students—for instructional as well as for preparatory and administrative purposes—and are more likely to increase their use of technology over time.[30]

Recent data suggest that digital content and networked applications are still supplementary to instruction for many teachers.[31] For instance, fewer than two in five public elementary and secondary school teachers currently employ computers or the Internet for most types of uses to a moderate or large extent, and only 20 percent of teachers with access to the Internet in their classroom use it to any extent.[32] In 1999, only ten percent of teachers reported feeling "very well prepared" and 23 percent reported feeling "well-prepared" to use computers and the Internet for classroom instruction.[33]

The CEO Forum on Education and Technology predicts exciting developments in the use of digital content and networked applications for instruction. In classrooms with ready access to these learning tools, these developments will allow for greater levels of collaboration, inquiry, analysis, creativity and content production.[34]

FIGURE 4. WELL-PREPARED TEACHERS INTEGRATE TECHNOLOGY INTO INSTRUCTION



Source: U.S. Department of Education, National Center for Education Statistics (2000). Teachers' Tools for the 21st Century: A Report on Teachers' Use of Technology, NCES 2000-102, by Becky Smerdon, Stephanie Cronen, Lawrence Lanahan, Jennifer Anderson, Nicholas Iannotti, and January Angeles. Washington, D.C.
http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2000102

WHAT IS DIGITAL CONTENT?

Digital content is the multimedia material that calls upon students to seek and manipulate information in the collaborative, creative, and engaging ways that make digital learning possible. It includes video on demand, CD-ROMs, Web sites, e-mail, on-line learning management systems, computer simulations, streamed discussions, data files, databases, and audio. Digital content is critical to digital learning because it can be:

- Randomly accessed;
- Relevant, up to date, and authentic;
- Explored on many levels;
- Easily manipulated;
- Instantaneous; and
- Creative

Source: the CEO Forum on Education and Technology (2001). The Power of Digital Learning: Integrating Digital Content. School Technology and Readiness Report – Year 3. Washington, D.C. http://www.ceoforum.org/downloads/report3.pdf

TECHNOLOGY'S IMPACT ON TEACHING AND LEARNING

Building upon a knowledge base developed over the past 40 years on the use of technology to improve teaching and learning,[15] the 1996 national educational technology goals laid the foundation for widespread improvements in student achievement. Recent research and evaluation substantiates what anecdotal evidence has suggested for quite some time about the effectiveness of computers and the Internet for education: It works.

Programs such as the Technology Innovation Challenge Grants have laid the foundation for advances in our understanding of effective uses of technology for teaching and learning. Challenge Grants—awarded to school districts in partnership with higher education institutions, museums, libraries, and private profit and non-profit organizations—are five years in duration and are intended to serve as educational technology testbeds. Recipients of these grants have developed and tested a wide variety of innovations, from virtual high schools (in which over 150 schools and 3,000 students participated in the 2000-2001 school year) to online teaching resources for geography and history. In fact, the U.S. Department of Education's Expert Panel on Educational Technology recently designated seven programs—several of which are Challenge Grants—as exemplary or promising educational technology programs on the basis of the quality of their program, educational significance, evidence of effectiveness and usefulness to others.

Studies have demonstrated that with technology student achievement increases, students can learn more in less time and undertake more ambitious school projects, and that students have more positive attitudes toward classes that use technology.[16] In fact, as briefly described in the accompanying table, school improvement programs that employ technology for teaching and learning yield a host of positive results for students and teachers.

Given that many schools and classrooms have only recently gained access to technology for teaching and learning, the positive outcomes of these studies suggest a future for education that could be quite bright if the nation maintains its commitment to harnessing technology for education. The adoption of new and emerging technologies by schools and classrooms offers even more reason to be hopeful.

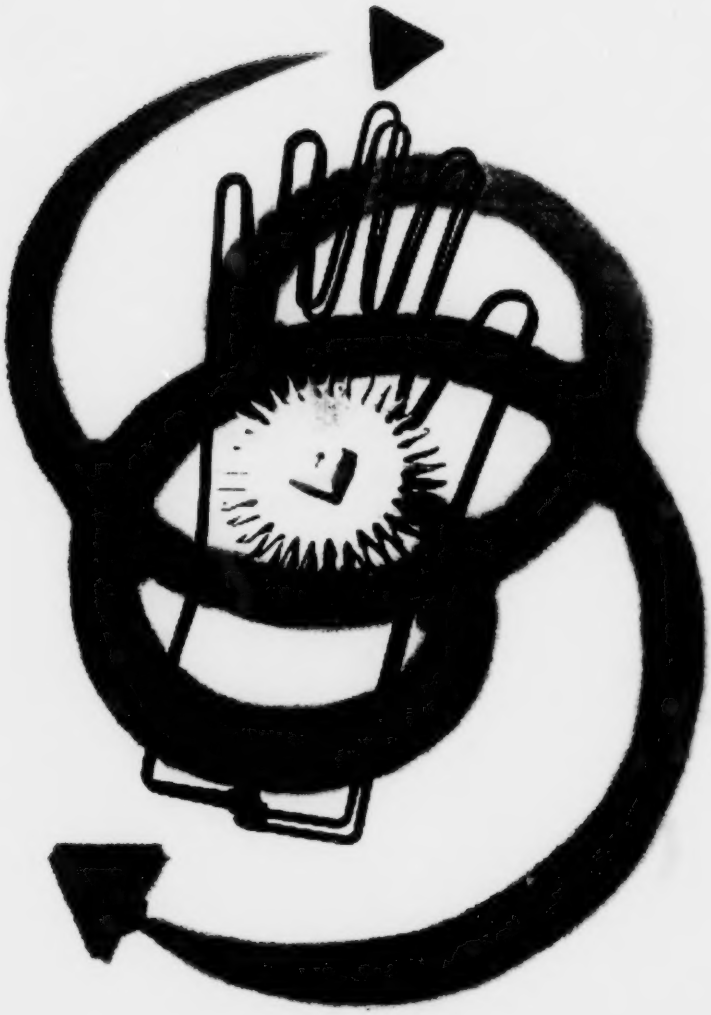
"STUDENTS RESPOND EXTREMELY WELL TO THE EASE AND SIMULATION PROVIDED BY THE VARIOUS TECHNOLOGIES AVAILABLE IN THE CLASSROOM. I SAW STUDENTS THREE TO FOUR GRADE LEVELS BEHIND THEIR AGE GROUP ABLE TO GAIN GROUND AND MOVE TO [THE NEXT] GRADE LEVEL BECAUSE OF THE TECHNOLOGY. THESE STUDENTS ENJOYED MAKING SOMETHING, SO THEY FOUND MOTIVATION TO IMPROVE THEIR READING SKILLS SO THEY COULD IMPROVE THE PRODUCT THEY CREATED."

–PARENT, ONLINE COMMENT TO U.S. DEPARTMENT OF EDUCATION

SELECTED EXAMPLES OF RESEARCH ON THE EFFECTIVENESS OF EDUCATIONAL TECHNOLOGY

YEAR	STUDY	PURPOSE	FINDINGS
2000	*Evaluation of the Use of Technology in Illinois Public Schools: Final Report* by Silverstein, Frechtling, and Miyaoka[11]	To determine the nature, extent, and effectiveness of the application of technology for improving education in Illinois.	Controlling for a school's poverty level, technology use has a small but significant impact on student achievement as measured by the Illinois testing program. The impact is generally strongest at higher grade levels.
2000	*Miami Dade County Public Schools Assessment Study: 1999-2000* by the Milken Family Foundation, Florida Educational Technology Corporation (FETC) and North Central Regional Educational Laboratory (NCREL)[10]	To recognize and ensure that the students of the Miami-Dade County Public Schools have the technology education they need to succeed in the digital age.	Innovative programs are found to be enhancing student learning through technology. Therefore, it is recommendended that the school administration take actions necessary to extend the benefits of technology use to all students.
1999	*Computer-Assisted Cooperative Learning in Integrated Classrooms for Students With and Without Disabilities* by Xin[9]	To determine the effects of computer assisted cooperative learning in classrooms for students with and without disabilities.	Students with and without disabilities achieved significantly higher scores through participation in computer assisted cooperative- learning groups than students who participated in whole-class learning.
1999	*The Idaho Technology Initiative: An Accountability Report to the Idaho Legislature on the Effects of Monies Spent through the Idaho Council for Technology in Learning* by The State Division of Vocational Education, The State Department of Education, Bureau of Technology Services[8]	To evaluate the impact of Idaho's investment in technology for learning.	The benefits of technology in teaching and learning included: increased academic achievement, improved technology literacy, increased communication, innovative teaching, positive relationships with the community, more efficient operation of schools, and technically qualified students ready to enter the workforce.
1999	*West Virginia Story: Achievement and Gains from a Statewide Comprehensive Instructional Technology Program* by Mann, Shakeshaft, Becker, and Kottkamp[7]	To investigate the effectiveness of the Basic Skills/ Computer Education (BS/CE) program in West Virginia.	Students participating in the BS/CE program achieved significant gains in reading, writing and math. Specifically, the program was found to account for 11 percent of students' improvements on the Stanford-9 from 1996-98. BS/CE was also found to be more cost-effective than other interventions and was especially successful with low-income and rural students as well as with girls.
1998	*Does it Compute? The Relationship Between Educational Technology and Student Achievement in Mathematics* by the Educational Testing Service[12]	To examine if technology increases achievement and if the methods in which it is used affects achievement.	Technology use by students was positively related to academic achievement, especially when used to teach higher-order thinking skills. Among other findings: for eighth-graders, the use of technology to teach higher-order thinking skills was related to a .42 gain of a grade level in academic achievement in mathematics, while using computers for learning games was related to a .15 gain of a grade level for fourth-graders.

YEAR[20]	STUDY	PURPOSE	FINDINGS
1998	*Project TELL Telecommunications for Learning: Report of a Seven-Year Study to Bell Atlantic* by Birenbaum and Kornblum[11]	To determine if under-achievement could be reversed through home access to computers and telecommunication networks.	Gains in motivation and performance were correlated to the time students spend on computer-based telecommunications environments in reading and math.
1998	*Rhode Island Teachers and Technology Initiative: Findings from the Pilot Year* by Henriquez and Riconscente[11]	To determine if providing training and laptop computers for teachers will contribute to school reform in the area of technology use.	Teachers who participated in the program noted positive changes in student abilities and work habits. Substantial changes to teachers' professional practices due to the program were also found, including teachers becoming more reflective about their teaching practices, spending more time advising their students, and spending more time working with other teachers on curricular and instructional planning.
1998	*The Effect of Hypermedia Authoring on Elementary School Students' Creative Thinking* by Liu[11]	To investigate the impact of hypermedia authoring on scores of creativity.	Engaging in hypermedia authoring resulted in significant gains for students on examinations measuring creativity.
1998	*The Union City Story: Education Reform and Technology - Students' Performance on Standardized Tests* by Chang, Henriquez, Honey, Light, Moeller and Ross[11]	To explore the difference in performance between students who have access to technology at home versus students who only have access to technology at school.	More access to technology does make a difference in student performance in writing, however, performance in math could not be contributed to greater access to technology.
1998	*Using the Internet to Enhance Student Understanding of Science: The Knowledge Integration Environment* by Linn, Bell and Hsi[11]	To determine whether Knowledge Integration Environment software programs helps increase students understanding of science and their ability to solve relevant problems.	The software allows students to interpret and apply significantly more complex pieces of information and was found to be motivating and exciting to students. In short, it contributed to students' understanding of science.
1997	*Word Processors and Children's Writing in a High-Computer-Access Setting* by Owston and Wideman[11]	To determine if a high-computer access environment and regular, sustained use of word processing software improved writing quality.	Students in high-computer-access schools made greater improvements in writing quality over the course of the study than did students who were in low-computer-access schools.
1996	*The Role of Online Communications in Schools: A National Study* by the Center for Applied "ocial Technology"[11]	To investigate the effects of online communications on student achievement and attitudes.	Online access can help students become more independent, critical thinkers, able to find information, organize it and evaluate it, and then effectively express their new knowledge and ideas in compelling ways.



CHAPTER 3

OPPORTUNITIES TO ENHANCE LEARNING WITH TECHNOLOGY

"LET'S USE THIS OPPORTUNITY TO FOCUS ON MORE THAN WIRES AND SCREENS. LET'S SEND A MESSAGE TO THE COUNTRY THAT EDUCATORS ARE LOOKING AT THE DELIVERY OF EDUCATION FROM THE PERSPECTIVE OF HOW CONTENT WILL IMPACT STUDENTS. THE INTERNET IS ONLY ONE TOOL FOR LEARNING. IT IS NOT A METHOD, IT IS SIMPLY A MEANS."

–JOHN RICHARDS, TURNER LEARNING, INC.
TESTIMONY TO THE WEB-BASED EDUCATION COMMISSION

Research has revealed that there are numerous opportunities to enhance learning through the use of technology. The National Academy of Science report on the new science of learning, *How People Learn: Brain, Mind, Experience, and School*, finds that new and emerging technologies have the potential to enhance learning and the development of new knowledge in many exciting ways.[20]

For instance, technologies can help students visualize difficult-to-understand concepts, such as differentiating heat from temperature. Visualization and modeling software similar to the tools used in the workplace increase students' conceptual understanding. Since new technologies are interactive, it is now easier to create environments in which students can engage in learning, receive feedback, and continually refine their understanding. In addition, new technologies provide access to a vast array of information, including digital libraries, real-world data for analysis, and connections to other people who provide information, feedback and inspiration—all of which can enhance the learning of teachers and administrators as well as students. Finally, new and emerging technologies also offer opportunities to individualize instruction and assessment in promising ways for all students, including especially those students at the greatest risk for school failure.[21]

This chapter highlights four of the most promising opportunities to enhance learning through the use of technology:

- Helping students to comprehend difficult-to-understand concepts;
- Helping students to engage in learning;
- Providing students with access to information and resources; and
- Better meeting students' individual needs.

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Transforming a Community with Technology

Hundred High School is a Blue Ribbon School located in a small rural community in West Virginia with an enrollment of approximately 170 students in grades 9-12. Since the school is in a remote area that did not have an Internet Service Provider, Hundred High School became the Internet Service Provider for its community. Students and teachers were given dial-in access and the community was transformed. After only one semester, 80 percent of the students accessed the Internet daily, compared to 26 percent before this project.

During 1998-99, the Student Utilization of Computers in Curriculum for the Enhancement of Scholastic Skills (SUCCESS) program was launched. As a result, every student in the school was provided a durable laptop, which could be used both as a stand-alone computer and as a wireless, networked computer. The laptops were loaded with a number of applications including word processing, spreadsheet and database software as well as a popular browser, email, a presentation creation package and a graphing program.

Not only does every student have a laptop, but every teacher also was given a laptop for instructional and classroom management tasks. In addition to the same application packages available to students, teachers were provided with an email package, an Internet browser and special classroom management tools.

Hundred High School teachers have incorporated this technology into daily classroom instruction in a number of ways. Through the use of several application software packages students are able to complete assignments using the application tools, using email for receiving and submitting assignments or collaborating with other students on group tasks, accessing information using the Internet browser, creating presentations to share with others and participating in mentoring projects. A visit to Hundred High School will find students in the school's greenhouse gathering data and entering it into spreadsheets and clustered in groups after school using their laptops. Students are able to access information anytime and anywhere.

Through the Wetzel County Board of Education, an important vehicle for enhancing school home communications has been added. Parents/guardians were included in the initial training and dissemination of the technology, and were encouraged to communicate with teachers and students using the technology provided to their children. Parents also have the opportunity to observe what their children are doing in the classroom by viewing assignments and files on the laptops.

To increase the level of success for this program, on-site teacher and student instructional training, and technical support was provided throughout the first year of implementation. Evaluation data of the program is being collected on a continual basis to establish the effectiveness of the program in terms of student learning as well as teacher progress in delivering instruction through this new technology model.

HELPING STUDENTS TO COMPREHEND DIFFICULT TO-UNDERSTAND CONCEPTS

For many students, the lack of visual representation of many higher-order concepts makes learning them difficult. In this regard, teachers have been limited in what they can teach by the tools to which they have access. New technologies allow teachers to teach complex ideas and address intellectual challenges more easily.

In the near future, students who have difficulties understanding text will be able to access multimedia resources in real-time through the Internet or stand-alone software, allowing them to better understand the relevant underlying principles. They will access video clips of conceptual constructs (e.g., an orbiting planet); definitions of specialized vocabulary (e.g., trajectory); links to other textual references (e.g., an interactive encyclopedia of the solar system); additional background knowledge (e.g., a narration about why it is important to learn about planetary orbits); pronunciations of unknown words; or a mini-lesson that might be tailored to help a child learn how to sound out an unknown word (e.g., a voice prompt "If you know that J-a-n-e-t is Janet, then pl-a-n-e-t would be ... planet.").[32]

Many students find it difficult to make connections between a mathematical expression and the situation to which it refers. Computers—which can draw graphs and other mathematical objects and allow students to "play" with them—can help students relate mathematical expressions to images in the "real" world. One way these connections can be made is with digital cameras. No longer are the pictures we take static objects; rather, as digital objects the pictures take on a new life that enables them to be closely linked with mathematical representations. For instance, software applications can provide tools to analyze motion as it is captured on a video camera and to create the corresponding graphs of changes in position or speed over time. Since the video and the graphs are linked, when the student points with the mouse to a point on the graph, the corresponding frame of the video is displayed.[33]

Exploratory data analysis software (and other visualization techniques) allows students to see patterns in data they would never glimpse if they had to do the calculations or even draw the graphs themselves—emphasizing the meaning of mathematical objects and the beauty of the patterns they exhibit. One such tool provides students with many ways to look at—and therefore understand—complex databases.[34]

Technology can be used in dance to document and analyze the dynamics of movement. For example, computer-aided choreography gives dance educators the ability to work out ideas of space and movement on screen without bringing the dancers together. Computer software created for movement notation allows teachers and students to create and edit dance notation scores very quickly.[35]

"I WAS FORTUNATE ENOUGH TO ATTEND EMERSON HIGH SCHOOL DURING THE UNION CITY REFORM. THE NEW SYSTEM THAT THE BOARD OF EDUCATION DEVELOPED INCLUDED TECHNOLOGY AS A KEY COMPONENT. NOW, WITH THE EASE AND AVAILABILITY OF THE INTERNET, STUDENTS ARE MORE ENGAGED IN THE LEARNING PROCESS…. STUDENT-TEACHER RELATIONSHIPS ARE STRONGER, AND STUDENTS EXHIBIT A CONFIDENCE THAT WAS NEVER APPARENT BEFORE THE REFORM. INTER-DISCIPLINARY PROJECTS DEMONSTRATE CONNECTIONS BETWEEN CLASSES THAT STUDENTS MIGHT NOT HAVE NOTICED OTHERWISE."

-MARIA JANELLI, STUDENT, ST. PETER'S COLLEGE, NEW JERSEY

TESTIMONY TO THE WEB-BASED EDUCATION COMMISSION

HELPING STUDENTS TO ENGAGE IN LEARNING

One of the most promising uses of technology in education involves teachers helping students actively engage in learning. In fact, the increasing power and versatility of computers create teaching and learning possibilities dramatically different from those that were previously available, providing teachers with the opportunity to enrich their instruction and students with the opportunity to contribute useful resources to others.

Technology resources and tools allow students to explore their areas of interest and to investigate topics that have been mere words in a textbook. For example, a group of students that chose to focus their research on ants created an animated simulation of the ant's anatomy, digitally recorded aspects of the ant's environment (which they compared with data on ants from other parts of the world), and followed ants with time-lapse video that they broadcast on the Internet. Technology was the tool that made possible this new approach to learning.[56]

Technologies such as CD-ROMs and robotics provide incredible resources for teachers. Microcomputer-based laboratories provide a wide range of probes—for pressure, temperature, alpha waves, heart monitoring, conductivity, sound, and motion—which along with the supporting software enable students to collect, display and analyze vast quantities of data over time periods ranging from seconds to days.[57] With these tools and access to the Internet, students can investigate weather patterns and their impact on the environment in countries thousands of miles away. They can employ digital geography and weather tools to examine the effects of a drought on local crops; track patterns of rainfall; simulate the effects of erosion with a software-modeling tool; chronicle population shifts; capture target information on random access video; formulate and support hypotheses about weather effects on culture; document their own conclusions about the event; and produce stories about the long-term ramifications of weather.[58]

Electronic keyboards are being used as classroom instruments, and computers are being used for creating and composing music. Video technology can make it possible for students to engage in all the aspects of theater just as professionals in the field work today. Set design, costuming, lighting and sound-control boards are all technology enhanced.[59] Through technology, students can participate in documentary TV productions, gaining experience as writers, producers, editors, directors, and set and graphic designers, while also learning about the topic on which they are reporting. Broadcasting segments to other students and teachers encourages feedback and helps students refine their ideas.[60]

Technology also allows students to learn about technology as they contribute useful resources to others. For example, students in New York created a Web site to inform and allay fears about orthodontic braces. On their Web site, the students gathered and offered advice, information and pictures from orthodontists; interviewed an oral surgeon; wrote a personal journal of one of the group's experiences with braces; designed an original cartoon story; provided recommendations on personal hygiene products, recipes and links to related sites; translated material into Russian; and encouraged other children to write about their own experiences with braces.[61] In these types of projects, it is the use of technology that actively engages students in the learning process in ways that are simply not possible for classroom teachers to reproduce without technology.

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The Internet, more so than any technology that has preceded it, provides students with access to a vast array of information and resources far greater than could ever be provided within the four walls of a classroom. Creative uses of the Internet allow for the establishment of "virtual" communities of learners, collectives of teachers and students from literally around the world assembling to learn from each other and to tackle real-world problems.

Digitized and multimedia primary sources on CD-ROMs and the Internet allow students to retrieve and analyze primary documents. How teachers use these resources ranges from simple Web exercises in which students must find a photo that tells something about work in the late 19th century to elaborate assignments in which students carefully consider how different photographers, artists and writers historically have treated the subject of poverty.[62]

Rapid advances in science and technology—due, for example, to recent advances in our understanding of genetic engineering and gene mapping—cause science textbooks to become out of date as soon as they leave the presses. To address this problem, a project was developed to provide up-to-date, age-appropriate Internet resources linked to specific textbook passages. Sites also provide teachers with access to information and pictures from areas and events that they might not be able to physically visit or see, such as deserts, hurricanes, oceans, salt marshes, tornadoes and volcanoes. Reviewed by a panel of science educators, these resources can be updated on a daily basis.[63]

Virtual communities of learners can take many forms. One project, organized through the Internet, allows hundreds of classes (particularly elementary school classes) to learn geography by exchanging postcards (real and virtual, purchased and computer generated) with each other. At an elementary school in Virginia, fifth-graders studying world cultures build a different "wing" of a virtual museum each year, researching and annotating cultural artifacts, and then posting them online.[64]

Peer review and feedback on networked computers allow students to share ideas and build on work collaboratively. For example, using one platform for these activities, students create notes on topics that are then shared with other students. The Internet is more recently being used for similar activities in which students share and collaborate in projects from other parts of the country or other parts of the world.[65]

COBB COUNTY SCHOOL DISTRICT, MARIETTA, GEORGIA

Education for a Sustainable Future

The Education for a Sustainable Future (ESF) project, a Technology Innovation Challenge Grant, helps teachers and students learn to see technology in the context of a sustainable future. Sustainable development issues are urgently needed in the nation's schools and, because they help students understand their futures, are inherently very interesting and motivating. This project is a five-year effort to develop, revise, and widely disseminate a collection of technology-based educational resources that fills this need.

It is having an extraordinary impact not only in Cobb and Fulton Counties, Georgia, where it began, but has already attracted and involved teachers from 35 additional states and three foreign countries in its first 3 years. One of numerous examples of positive student outcomes is illustrated by attendance improvement when ESF is the topic. One high school teacher designated every Friday "EFS day," and she documented 100 percent attendance every Friday for two years with her at-risk classes.

Learning what it means to be a responsible citizen in a technological society is at the core of the ESF project. Much of the technology rich curriculum and the software created to support that curriculum, address the issues of democracy through the lenses of the environment, the economy, society and technology.

For example, a third grade class studied land use changes in their community using a variety of technology tools. Concerned about the pattern of change and the poor quality of development they discovered, they invited the local mayor, a 19-year veteran of the zoning board, to speak to them. They wanted to know about laws and plans for clear-cutting, traffic control, and neighborhood park improvements. The Mayor was caught a bit off guard when asked what the Internet has meant to zoning. "We've been working on our Web site for about two years and we're almost ready to launch it," he smiled. Technology is something these students take for granted and depend on. "What we are teaching is local and current," teacher Eva Cronin explains. "You can't find that information in a textbook, so the Internet is an invaluable resource for us."

"I GO ONLINE TO SEEK MATH HELP AT TIMES. AS FOR SCIENCE, A FEW BUDDIES AND I MADE A CHEMISTRY ONLINE WEB SITE SO STUDENTS WOULD CONTACT EACH OTHER AND TEACHERS TO GET HELP IN OFF-SCHOOL HOURS, AND IT WOULD KEEP THEM UPDATED ON INCOMING ASSIGNMENTS AND TESTS."

-STUDENT, INTERNET CHAT WITH U.S. DEPARTMENT OF EDUCATION

While many of these online communities are interdisciplinary, they can also be subject specific. For example, the best-known example of an online mathematics community is the Math Forum site, which includes a large list of resources for kindergarten through college math teaching. These resources include interactive activities; recommendations of software; examples of classroom activities and links to related discussion groups; a conversation space for teachers; an extensive math library; an Ask Dr. Math feature, in which an expert answers students' questions; Problems of the Week at a variety of levels of difficulty; discussion groups on topics such as discrete math and a multilingual discussion on the history of mathematics; and a showcase highlighting recently added material. This site has served as an important portal for mathematics educators and students and as a kind of social center for the mathematics education community.[66]

Through the Internet, students also have a chance to work interactively in the "real" world. Many links have been established between practicing professionals and schools where students actually assist in solving problems that professionals in the field are currently working on. In such situations, students are able to work on and develop problem-solving skills in realistic workplace situations. Some projects actually depend on students to contribute information that professionals then use in their work. In project GLOBE, students and teachers from over 9,500 schools in more than 90 countries contribute data from their local environment. These data are then used by both students and scientists for environmental analysis.[67]

BETTER MEETING STUDENTS' INDIVIDUAL NEEDS

One of the most powerful opportunities afforded education by technology is the opportunity to better meet students' individual learning needs. In addition to creating more engaging content, technology will allow better and more accurate assessments of what students know, where they are having difficulties, and how their teachers could best convey the knowledge and skills students need. Access to real-time tutoring will also increase, with opportunities being made available over the Internet. Importantly, in creating technologies that work better to meet students' individual needs, all students will benefit, including students with disabilities and students considered at-risk of school failure. As Secretary Riley has said, "Assistive technologies help children with special needs communicate via e-mail, conduct research on the Internet, and become full participants in school activities. Technology has also made a difference for gifted and talented children, allowing them to learn at their own pace and explore subjects in greater depth. As parents know, every child has special needs and every child deserves individualized instruction. Effective education technology can help teachers challenge all students to do their very best."

With the evolution of the Internet, opportunities to improve traditional assessments are created.[68] Many aspects of assessment—development, delivery, administration, scoring and distributing results—can be performed in a more cost-effective and efficient manner using online technology. Along with these obvious benefits come more subtle benefits. Teachers could almost instantly gain substantial insight into the problems that their students face. Also, the ability to customize assessment will mean that teachers can identify the personal

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PROJECT ESTRELLA

Encouraging **S**tudents through **T**echnology to **R**each High **E**xpectations in **L**earning, **L**ifeskills and **A**chievement

ESTRELLA, one of five technology programs funded by the U.S. Department of Education's Migrant Education Program, addresses the educational needs of migrant farmworker youth through technology. ESTRELLA serves about 150 migrant students who migrate between Texas and Illinois, Montana and New York. These students would otherwise not complete the coursework in a traditional school setting. While only 50 percent of migrant students nationwide graduate from high school, all of the participating seniors in 1999 graduated, and 80 percent enrolled in postsecondary education.

ESTRELLA provides laptop computers, training on computer use, a toll-free number dial-up number, cybercounselors from the University of the Incarnate Word (UIW), and credit-awarding coursework via NovaNet to students. Students use these resources to complete the coursework required for graduation while living away from their home states during migration periods.

The program encourages active support and learning on the behalf of parents as well. Parents are required to complete a training course and sign contracts to protect laptop and support the student in his/her use. Parental involvement is a key criteria in the selection process.

strengths and weaknesses of each student. As technology changes the way students learn, the need for assessment to reflect these changes is also important. Indeed, recent research has suggested that in open-ended examinations, the performance of students who are accustomed to writing on computers is not accurately assessed on traditional pencil-and-paper examinations.[69]

The availability of real-time tutoring over the Internet also provides opportunities for more individualized instruction to those students (elementary, secondary and postsecondary) who need it. Technology allows tutors to work one on one with students online, 24 hours a day. Internet chat rooms and other virtual workspaces allow students to work collaboratively with each other, in study sessions with a tutor or in homework groups. Some sites also provide opportunities for students to post and view responses to homework questions.

LOOKING FORWARD

Since 1996, the nation has demonstrated an unprecedented commitment to employing technology for improved teaching and learning. Looking forward, the leadership imperative is to provide all teachers and students with the access and support they need to employ new and emerging communications and information technologies to facilitate learning in ways that were never before possible.

With access and support, teachers will better be able to help their students to comprehend difficult-to-understand concepts and engage in learning, provide their students with access to information and resources, and better meet their students' individual needs. If we take advantage of the opportunities presented to us, technology will enhance learning and improve student achievement for *all* students.

CHAPTER 4

THE LEADERSHIP IMPERATIVE:

A NATIONAL STRATEGY FOR TECHNOLOGY IN EDUCATION

"THIS DEBATE HAS NEVER BEEN ABOUT TECHNOLOGY. IT HAS BEEN ABOUT WHAT OUR CHILDREN HAVE THE OPPORTUNITY TO DO. IT'S ABOUT MUCH MORE THAN JUST GIVING A YOUNG PERSON A COMPUTER OR CONNECTING THAT PERSON TO THE INTERNET. IT'S ABOUT CONNECTING STUDENTS TO A WHOLE NEW WORLD OF LEARNING RESOURCES AND OFFERING THE MIND THE OPPORTUNITY TO EXPAND AND TAKE ON A NEW AND CHALLENGING FUTURE."

-SECRETARY RICHARD W. RILEY, U.S. DEPARTMENT OF EDUCATION

NATIONAL EDUCATIONAL TECHNOLOGY GOALS

In 1996, four national educational technology goals were developed. Together, they dealt with the critical issues facing elementary and secondary schools seeking to increase the effective use of technology in education at that time: training and support, computer access, Internet access and content. Given the tremendous progress in achieving these goals and on the continued changes in the capabilities and affordability of technology, it became evident that there was a need to move beyond the 1996 goals.

In the fall of 1999, the U.S. Department of Education undertook a strategic review and revision of the national educational technology plan, in consultation with the full range of stakeholders: educators, researchers, policymakers, students, parents, and leaders from higher education, industry and other areas.[6] The outcome of this strategic review was the development of five new national goals for technology in education. Working together to achieve these goals constitutes a major leadership imperative facing those seeking widespread improvements in teaching and learning. Indeed, nothing less than the future economic well-being of our nation is at stake. As a nation, we should pledge to meet these new goals:

NATIONAL EDUCATIONAL TECHNOLOGY GOALS

Goal 1: All students and teachers will have access to information technology in their classrooms, schools, communities and homes.

Goal 2: All teachers will use technology effectively to help students achieve high academic standards.

Goal 3: All students will have technology and information literacy skills.

Goal 4: Research and evaluation will improve the next generation of technology applications for teaching and learning.

Goal 5: Digital content and networked applications will transform teaching and learning.

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In committing to achieve these goals, everyone has a role to play: federal, state and local governments; education; nonprofit organizations and associations; the private sector; communities; and families. This chapter presents some of the key components of a national strategy to ensure that the nation takes maximum advantage of the opportunities afforded by technology in education.

Goal 1: All Students and Teachers Will Have Access to Information Technology in Their Classrooms, Schools, Communities and Homes.

An integral part of school improvement and reform efforts in the 21st century, in the United States and abroad, will be student and teacher access to educational technology, such as computers connected to the Internet. Universal access to the Internet will help end the isolation of teachers; exponentially expand the resources for teaching and learning in schools and classrooms; provide more challenging, authentic and higher-order learning experiences for students; and make schools and teachers more accountable to parents and communities.

The quality of Internet access is critical. Broadband access will be the new standard. Slow, unreliable connections that cannot support interactivity or rich multimedia content will no longer be sufficient. To take advantage of access to technology for improved teaching and learning, it will become increasingly important to build and support network infrastructures—wired or wireless, desktop or handheld—that allow multiple devices to connect *simultaneously* to the Internet throughout every school building and community in the nation.

As the American education system is beginning to realize the impact of technology on teaching and learning, other countries are making significant commitments to the use of technology for education. Political recognition of its importance is reflected in high-profile plans to make access to computers and to the Internet universal in many Organization for Economic Cooperation and Development (OECD) countries, including the "The National Grid for Learning" in the United Kingdom, and "Schulen and Netz" in Germany.[71] Perhaps most significant, some people in Asia claim that the region is home to the most distance learners in the world, as evidenced by surging enrollments of distance-oriented universities with more than 100,000 students in China, India, Indonesia, South Korea and Thailand, among other Asian nations.[72] Indeed, countries such as China and India are making their own multi-million dollar investments in technology for education.[73] Nothing less than the ability of the American workforce to remain competitive in the global economy is at stake.

"EDUCATION AND TRAINING ARE CENTRAL TO HOW NATIONS WILL FARE IN THE FUTURE. STRONG NATIONS AND STRONG COMMUNITIES WILL DISTINGUISH THEMSELVES FROM THE REST BY HOW WELL THEIR PEOPLE LEARN AND ADAPT TO CHANGE. THE TASK OF EDUCATION MUST THEREFORE BE TO PROVIDE THE YOUNG WITH THE CORE KNOWLEDGE AND CORE SKILLS, AND THE HABITS OF LEARNING, THAT ENABLE THEM TO LEARN CONTINUOUSLY THROUGHOUT THEIR LIVES. WE HAVE TO EQUIP THEM FOR A FUTURE THAT WE CANNOT REALLY PREDICT."

-PRIME MINISTER GOH CHOCK TONG, SINGAPORE

"IF WE TRULY WANT TO CLOSE THE DIGITAL DIVIDE, THE TECHNOLOGY INDUSTRY MUST FOCUS ON IMPROVING QUALITY AND LOWERING COST. BUT MORE IMPORTANT, WE MUST MAKE IT RADICALLY SIMPLE FOR CONSUMERS TO USE TECHNOLOGY AND CONNECT TO THE INTERNET."

-ERIC BENHAMOU, CHAIRMAN, 3COM CORPORATION

To realize the goal of universal access to educational technology for students and teachers, we should:

→ **Ensure sustained and predictable funding for technology to realize large-scale impact.** For states, districts and schools to engage in effective planning and realistic budgeting for the effective use of technology, sustained and predictable funding sources are needed. Sustained and predictable funding sources reinforce the long-term nature of the investments and allow states, districts and schools to plan for the total cost of providing access to technology (i.e., for instructional and technical support; for software, digital content and online connection charges; for maintenance, upgrades and repairs).

→ **Ensure that technology plans reflect the educational needs of students and are regularly updated.** Planned investments for technology in education will be most effective when they:

- Complement and support students in achieving state and local standards for what they need to know and be able to do;
- Consider a full range of technologies, taking into account the developmental and educational needs of students;
- Consider the role of and need for parental and community access to technology;
- Address the technical support, maintenance and professional development needs of teachers and school staff;
- Demonstrate leadership through targeting resources to the areas of greatest need in amounts sufficient to make a difference;
- Address issues of Internet safety, including responsible and age-appropriate student technology use;
- Take into consideration access to and use of technology both inside and outside of school for teachers, students and their families; and
- Reflect lessons learned from previous technology investments, including assessments of the strengths and weaknesses of partnerships with other organizations and agencies.

→ **Improve the affordability, reliability and ease of use of educational technology.** While desktop computers are powerful and flexible educational tools, they can be complex to operate and expensive to maintain. New technologies, developed with the needs and budgets of educators and students in mind, offer opportunities to expand access to powerful learning opportunities. These technologies include handheld devices, such as personal digital assistants (PDAs) and graphing calculators, as well as devices that make it easier to connect to the Internet, such as through TV sets or other Internet appliances. Developers should work with researchers and educators to create new and affordable tools for education. Other strategies to improve access to technologies include developing cost-effective models of purchasing or leasing educational technology.

"THEY'VE GOT TO HAVE ACCESS. THE INTERNET CAN EITHER BE THE GREAT EQUALIZER, OR JUST ANOTHER MISSED OPPORTUNITY….ACCESS MAKES THE DIFFERENCE."

-WILLIAM KENNARD, CHAIRMAN, FEDERAL COMMUNICATIONS COMMISSION

- **Ensure that school buildings and facilities are modern.** While there are several pre-conditions for effective teaching and learning supported by technology, one of the greatest challenges relates to the need for adequate school buildings and facilities. For instance, at least one environmental factor—such as lighting, heating, ventilation, indoor air quality, acoustics or noise control, or the physical security of buildings—is in unsatisfactory condition in many school buildings.[74] About a third of schools are not satisfied with the energy efficiency of the school, and nearly four in ten are unsatisfied with the flexibility of instructional space.[75] States should consider requiring districts or schools to maintain a written long-range educational facilities plan that describes the impact of the increased use of technology on each school building and how any shortcomings could be addressed.

- **Strengthen our commitment to eliminating the digital divide.** In the long run, our goals for access are greater than ensuring that every school or classroom has a connection to the Internet. Our goals should include ensuring universal access in communities and homes. In the future, universal access to the Internet in communities and homes will allow students of all means to complete school assignments at home, study with their peers, improve parental involvement in education and foster lifelong learning for all family members.

  Today, the digital divide remains a real and persistent threat to the economic well-being of our country. We must strengthen our commitment to eliminating the digital divide through a variety of governmental and private initiatives. Leadership and creativity are required to target sufficient resources to those schools serving children most in need and to develop and implement classroom-, community- and home-based programs to provide technology resources, training and support to those currently without access.

- **Ensure that all students have equal opportunities to access and use technology.** Access alone is insufficient if other barriers to the effective use of technology manifest themselves. We must be vigilant in ensuring that teachers use technology to create classroom environments that are inclusive and engaging for students with varying backgrounds, languages, cultures, abilities, disabilities, interests, and motivation. Only in this way will the opportunities afforded by technology be used wisely and creatively to support instruction and learning for every student.

Goal 2: All Teachers Will Use Technology Effectively to Help Students Achieve High Academic Standards.

Most teachers have been prepared for a model of teaching dramatically out of step with what is needed to prepare the nation's students for the challenges they will face in the future. To increase the frequency and variety of effective technology use for teaching and learning, it is vital that both new and existing teachers be well prepared. Recent reports by the American Council on Education, the CEO Forum on Education and Technology, the Milken Exchange on Education Technology, the National Commission on Mathematics and Science Teaching for the 21st Century, and the National Council for Accreditation of Teacher Education, among others, all identify opportunities to enhance teacher quality and teacher preparation, particularly as it relates to the effective use of technology in education.[76]

One comprehensive, promising initiative—the International Society for Technology in Education's (ISTE) National Educational Technology Standards (NETS) for Teachers Project—has provided a framework for employing technology in teaching and learning to help students achieve high academic standards that has been widely used in universities, state departments of education and school districts across the nation. Specifically, teachers should:

- Demonstrate a sound understanding of technology operations and concepts;
- Plan and design effective learning environments and experiences supported by technology;
- Implement curriculum plans that include methods and strategies for applying technology to maximize student learning;
- Apply technology to facilitate a variety of effective assessment and evaluation strategies;
- Use technology to enhance their productivity and professional practice; and
- Demonstrate an understanding of the social, ethical, legal and human issues surrounding the use of technology in education.[77]

Ensuring that the nation has effective 21st-century teachers requires more than just providing sufficient access to technology for teaching and learning. Additionally, we should:

→ **Improve the preparation of new teachers, including their knowledge of how to use technology for effective teaching and learning.** The demographics of today's teaching force are stunning: one-third of today's teachers have more than 20 years of experience, and two-thirds are at least at mid-career.[78] At the same time, K-12 enrollment is the highest it has ever been in the United States, surpassing the explosive enrollment of the baby-boom years. The 53 million students expected by 2010 will stretch the capacity of the nation's schools for years to come.[79] Consequently, over the next decade, more than two million new teachers are expected to be employed to replace retiring teachers, meet growing school enrollments, lower class size, and replace teachers who have left the profession.[80] Preparing these new teachers to effectively use technology in their instruction and for their own professional and administrative purposes represents an unprecedented opportunity to update the knowledge and skills of the teaching force to better reflect changes in society. Specific actions to ensure such preparation could include:

  - Providing faculty in schools of education with the tools, incentives, and ongoing professional development they need to integrate technology into the teacher training curriculum;
  - Encouraging states to expand teacher licensure and certification programs to include proficiency in integrating technology into the curriculum;
  - Establishing partnerships among schools of education and exemplary technology-using elementary and secondary schools to improve the student teaching experience of new teachers; and,
  - Developing and disseminating more effective models of teaching and learning.

"THE TECHNOLOGICAL TOOLS ARE AVAILABLE FOR CREATING COMPREHENSIVE PLATFORMS FOR TEACHER PROFESSIONAL DEVELOPMENT THAT PUT THEIR LEARNING IN THE CONTEXT OF WHAT THEY DO EVERY DAY IN INSTRUCTION."

—ROY PEA, SRI INTERNATIONAL, INC. — TESTIMONY SUBMITTED TO NATIONAL COMMISSION ON MATHEMATICS AND SCIENCE TEACHING FOR THE 21ST CENTURY

→ **Increase the quantity, quality and coherence of technology-focused activities aimed at the professional development of teachers.** Research has clearly demonstrated that the more professional development teachers receive, the better prepared they report feeling to use technology. Well-prepared teachers use technology more frequently, use it in a greater variety of ways individually and with their students—for instructional as well as preparatory and administrative purposes—and are more likely to increase their use of technology over time. Teachers who are most technically knowledgeable about computers are more likely to have their students use computers as productivity tools in complex projects that may involve higher-order thinking, designing a product, and explaining their ideas and constructions to an external audience.

Specifically:

- States and districts should treat the provision of professional development as a priority, developing *systematic* plans and approaches to providing their teachers with the skills and knowledge they need to adapt to the changing requirements of education;
- Content associations and organizations, media companies, and other private-sector organizations can also play a role in developing high-quality professional development materials and delivering training to assist teachers to effectively integrate technology into their teaching; and
- States and districts should explore opportunities to employ technology as a more effective (and cost-effective) means of providing high-quality professional development opportunities to teachers.

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- **Improve real-time instructional support available to teachers who use technology.** High-quality, comprehensive instructional support is critical in assisting teachers to integrate technology into their instruction. Such support may include the availability of just-in-time individualized training and professional development activities, with content that focuses on supporting teachers to integrate the technology available to them into their instruction. Technology coordinators also play a critical role in fostering the effective use of technology in schools through their knowledge of both technical and instructional issues. Strategies include:

  - States, districts, content associations and organizations, and private-sector organizations should develop online resources to provide just-in-time support to teachers. Specific examples include education-focused portal sites for teachers, which offer online communities for professional development or mentoring, tools for classroom management and administrative tasks, and tools to facilitate increased communication with parents and community members.

  - Educational technology organizations should consider developing national standards and certification programs for technology support professionals and programs.

  - Districts and schools should develop comprehensive technology support programs, directed by qualified technology coordinators at each school building, and

  - States, districts, and schools should investigate emerging approaches to providing technical and instructional support over the Internet by building, using, or purchasing teacher-specific resources online.

Goal 3: All Students Will Have Technology and Information Literacy Skills

Since nearly half of all U.S. workers will be employed in industries that produce or intensively use information technology products and services by 2006,[*] it is hardly surprising that there have been repeated calls for students to develop technology and information literacy skills. In fact, the need to prepare students with the skills they need to participate fully in our increasingly technological society has been a longstanding priority for the nation.

A meaningful, unified approach to providing students with the skills they will need for their futures must be more than a checklist of isolated technology skills, such as knowing the parts of a computer, writing drafts and final products with a word processor, or searching for information using a CD-ROM database.[*] Rather, technology skills are only a first step in assuring all our children become proficient information and technology users. Also necessary are information literacy skills such as:

- **Task definition**—The first step in the information problem-solving process is to recognize that an information need exists, to define the problem, and to identify the types and information needed.

- **Information seeking strategies**—Once the information problem has been formulated, the student must consider all possible information sources and develop a plan for searching.

- **Location and access**—After students determine their priorities for information seeking, they must locate information from a variety of resources and access specific information found within individual resources.

- **Use of information**—After finding potentially useful resources, students must engage (read, view, listen) the information to determine its relevance and then extract the relevant information.

- **Synthesis**—Students must organize and communicate the results of the information problem-solving effort.

- **Evaluation**—Evaluation focuses on how well the product meets the original task (effectiveness) and the process of how well students carried out the problem-solving process (efficiency).[*]

The 21st Century Workforce Commission concluded that nothing less than the future health of America's 21st-century economy depends directly on how broadly and deeply Americans reach a new level of literacy that includes not only strong basic academic skills, but also thinking, reasoning and teamwork skills, as well as proficiency in using technology.[84] The call for this new "21st-century literacy" in no way supplants current efforts by states and districts to set and even raise academic standards for students; it simply reflects the fact that the bar for an educated citizenry and workforce continues to rise to reflect changes in society.

In requiring these skills of students, we will ensure that the opportunities made possible through the use of technology will be available to all students as they progress through school, regardless of personal or socioeconomic factors. Even for those students who do not pursue technology careers, ensuring technology and information literacy skills will provide a number of benefits. In fact, everyone—from corporate executives and others in the business world, brokers and investment analysts, journalists, teachers, doctors, nurses, farmers, and homemakers—all will be able to perform their jobs better if they have technology and information literacy skills. On the individual level, technology and information literacy skills will help consumers better assess products and make more intelligent buying decisions. And, on the societal level, technology and information literacy skills should help citizens make better decisions through heightened understanding of the scientific and technological foundations of many public policy issues facing the nation and the world (such as genetic engineering and global warming).[85]

In addition to providing sufficient access to technology for teaching and learning, to ensure that students are prepared for their future we should:

➔ **Include technology and information literacy skills in state and local standards for what students should know and be able to do.** We should ensure that in addition to mastering fundamental literacy and mathematics skills, students are able to demonstrate age-appropriate technology and information literacy skills, such as how to define tasks, identify information seeking strategies, locate and access information, determine information's relevance, organize and communicate the results of the information problem-solving effort and evaluate the effectiveness and efficiency of the solution. Specifically:

- States and districts should look to national organizations such as ISTE and the International Technology Education Association (ITEA) for guidance on the adoption or development of their own student technology and information literacy skill standards.

- National organizations and the private sector can create materials and tools to help teachers prepare students to meet new technology and information literacy skill standards.

- Employers should work with local districts and schools to ensure that the specific technology and information literacy skills in demand are being taught.

Supporting Safe Student Searching on the Internet

Most students who go on-line have positive and rewarding experiences, but educators cannot ignore that there is inappropriate material on the Internet. In the fall of 1997, the Fairfax County Public Schools (FCPS) School Board addressed the challenge of Internet safety by directing the school administration to examine the technologies available to protect students from accessing inappropriate material on the Internet. A working group that included over 500 parents and community members, teachers and students was formed to study the issue and draft policy. The Fairfax County Public Schools implemented an Internet safety strategy based upon the findings of the working group. The three-part strategy consists of:

I. ACCEPTABLE USE POLICY: All parents and students must sign the acceptable use policy which includes three sections: (1) Respect for Others, (2) Ethical Conduct for Users and (3) Respect for Property. The Ethical Conduct section states that students should "restrict the use of the FCPS network and resources to the mission or function of the school system."

II. TEACHER EDUCATION: The teacher's role is critical to ensuring that students are using the Internet appropriately as an effective educational tool. As part of ongoing professional development, teachers are provided classroom management techniques that promote Internet safety. Some strategies include:

- Educating teachers on Internet safety practices.
- Identifying effective techniques for identifying and evaluating safe Web sites.
- Using child-safe search engines.
- Arranging computers to enable the teacher to easily see the monitors of all computer systems.
- Sharing best practices on the Internet.
- Developing a brochure and/or educational video to assist teachers, students and parents.

III. TECHNOLOGICAL SOLUTIONS: In Fairfax County, the School Board policy provides protection from inappropriate Internet material by preventing access to "content known to be obscene, harmful to juveniles, or child pornography." They employ a contractor to sort Internet sites by category (e.g. "sex acts"). The district identifies the categories that they want blocked and the server-based lists are remotely updated every night by the contractor. When someone tries to access a Web site that has been put on the restricted list, it is blocked and the user is sent a message.

→ **Ensure students use technology appropriately and responsibly.** Research suggests that students can use technology most successfully when that use is age-appropriate. However, some have pointed out that inappropriate uses may lead to increased risks of emotional and physical health hazards.[86] Students also must understand that along with the privileges associated with using technology comes a great deal of responsibility, such as how to navigate the Internet while avoiding inappropriate material and safeguarding personal information. In addition, students must safeguard technological hardware and software by protecting it from damage or misuse. In their final report to the U.S. Congress, the Commission on Online Child Protection indicated that no single technology or method can effectively protect children from harmful material online.[87] Consequently state, district and school technology plans need to consider a range of approaches to ensuring students use technology appropriately and responsibly. Specifically:

- Students, teachers, and parents should be required by their schools, districts or states to agree to follow acceptable use policies dictating the appropriate standards of behavior expected from the educational use of the Internet and the consequences for violating these standards.
- Schools and districts should develop Internet safety plans.
- Schools and districts should employ technological and non-technological methods to protect children from inappropriate material.
- Internet sites maintained by states, districts and schools should provide families and students with detailed information about the technologies and methods available to protect children online, instructions on how to report trouble, and links to resources for more information (such as to law enforcement and child advocacy organizations).
- States and districts should develop Internet safety curricula and supporting materials for all teachers to use with their students.
- States, districts, and schools should employ protective technologies—such as filtering and blocking technologies, monitoring technologies, and child-safe sites—as one component of their Internet safety programs.
- Producers of online content should develop next-generation systems for helping parents and teachers prevent students from accessing inappropriate content.

Develop new student assessment tools. Emerging research suggests that traditional paper-and-pencil assessments may no longer accurately capture the learning of 21st-century students. In addition, through innovative private- and public-sector collaborations, technology itself will offer opportunities to improve the assessment of students. Other opportunities to increase our understanding of student assessment include participating in international comparative work currently underway. These cross-national studies, led by the International Association for the Evaluation of Educational Achievement (IEA) and the Organization for Economic Cooperation and Development (OECD), provide unprecedented opportunities to learn from the experiences of other countries that are also engaged in efforts to improve student assessment.

Advances in Student Assessment

State and national standards call for students to master not only challenging content knowledge but also the inquiry and problem solving skills they will need to be productive workers and citizens in the 21st century. Skills in planning how to address a problem, working in collaborative teams, locating relevant, accurate information, drawing conclusions based on data, and communicating findings are critical aspects of school, work and life in general. Yet conventional assessments- multiple-choice or short-answer paper-and-pencil tests- do not capture these essential skills. Hands-on performance assessments, intended to address these skills, are widely regarded as difficult and expensive to construct and administer.

SRI International's Center for Technology in Learning (CTL) is exploring the potential for technology to support more effective assessments of 21st-century skills. Several of CTL's new assessments have been developed under a grant from the U.S. Department of Education's Office of Educational Technology. One of the prototype assessments has students search through Web resources, identify relevant information, make judgments about the credibility of Web site information and claims, and then make and communicate a decision based upon the information they have obtained through their Internet search. The entire assessment is administered online, with students using real Web resource materials.

A second prototype assessment developed under the same grant makes use of palm-top computing devices as an aide to the assessment of students' collaboration skills. The teacher first uses a Web interface to review the particular dimensions of collaboration- distilled by SRI researchers from the research literature- he or she wishes to assess. For each dimension, a three-category scoring rubric is provided. The teacher downloads the selected assessment dimensions onto a palm-top computer, which the teacher then uses as a prompt and an information storage device while circulating from group to group observing student interactions. The student groups can also use the palm-top assessment, with each group rating its own performance on the dimensions selected by the teacher. SRI expects to have refined versions of these assessments available from the CTL Web site by summer 2001 (www.sri.com/policy/ctl/).

Other CTL-developed Web-based assessments ask students to work with scientific data, identifying which data are relevant to making a decision, analyzing that data, and then preparing a presentation using data to support their conclusion. By using technology, these assessments can provide students with realistic, motivating problem contexts: information and data of the kinds used in real-world decision tasks; and a rich, high-fidelity mode of demonstrating what they understand and can do. Moreover, Web accessible assessments can be used by students anywhere there is Internet access, and provide test developers with efficiencies associated with automated scoring and with re-using software components across assessments.

Strengthen partnerships with industry to help meet the workforce needs of the future. One purpose of elementary and secondary education is to provide students with the skills they need to become productive members of the workforce. Recognizing business interest in a highly qualified workforce, organizations such as the Business Coalition for Education Reform, the Business-Higher Education Forum, the Business Roundtable, the Committee for Economic Development, the Council on Competitiveness, the National Alliance of Business, and the U.S. Chamber of Commerce coordinate private sector activities aimed at improving education. To help meet the workforce needs of the future:

- Individual businesses and business organizations should create innovative technology training and apprenticeship programs for high school students.

- States, districts and schools should establish partnerships with local businesses and national and state business organizations to gain support for school improvement efforts.

- Given the need for higher quality mathematics and science teaching—as found by the National Commission on Mathematics and Science Teaching for the 21st Century—businesses should "lend" qualified employees to act as part- or full-time teachers in local schools, without incurring loss of pay or benefits, as well as make regular contributions of time, materials and resources to enhance instruction in mathematics and science instruction in local schools.[48]

Goal 4: Research and Evaluation Will Improve the Next Generation of Technology Applications for Teaching and Learning.

At the dawn of the 21st century, we are still at the beginnings of a technological revolution that is bringing dramatic changes to our society. This technological revolution will not automatically translate into a similar revolution in teaching and learning. While we have learned a tremendous amount about the implementation and use of technologies for teaching and learning in the past few years, the need for an expanded, ongoing national research and evaluation program to improve the next generation of technology applications for teaching and learning is profound.

To implement such a program requires a sustained, multi-disciplinary collaboration of learning scientists, technologists, and subject-matter experts. Numerous organizations have pointed out the urgency of this national need, including the President's Committee of Advisors on Science and Technology, the U.S. Department of Education, the National Science Foundation, the National Research Council, private charitable foundations, independent research institutes and representatives of academia.[49]

To ensure that research and evaluation will improve the next generation of technology applications for teaching and learning, we should:

Initiate a systematic agenda of research and evaluation on technology applications for teaching and learning. There is a pressing need for a high-quality, long-term national agenda for collecting, analyzing and disseminating information on the use and effectiveness of technology in education. Such an organized agenda could consist of:

- Basic research in various learning-related disciplines and fundamental work on various educationally relevant technologies.

- Early-stage research to improve the state-of-the-art in educational hardware and software, digital content, networked applications, and other technology-enabled applications of pedagogy and assessment.

- Empirical studies—conducted in schools and classrooms—designed to determine which approaches to the use of technology are most effective and under which conditions with which students.

- Evaluations of federal, state and local programs with a substantial technology component to gather the necessary information to adjust their operation so that they better meet intended purposes.

- Descriptive studies of the availability and use of technology in classrooms, schools and communities to allow the nation to continue to track progress in integrating technology into education.

- International comparative studies to benefit from innovations in using technology in education occurring elsewhere in the world.

Any systematic approach to conducting research should involve an upgrading of the capacity of the U.S. Department of Education to manage the national research agenda. In addition, the implementation of a national research agenda will require a sustained, multidisciplinary collaboration with learning scientists, technologists, and subject-matter experts.

➔ **Encourage state and local evaluations of technology programs.** There are many valuable reasons to evaluate a program, including: (a) to provide information to program personnel and others on aspects of the program that work well and potential problems; (b) to catch potential problems early in the program so they can be corrected before more serious problems occur; (c) to guide further evaluation efforts (e.g., an evaluation may bring to light issues that need to be examined in greater detail or an initial evaluation of program implementation may be used, in part, to guide a later evaluation of long-term impact); (d) to provide information on what technical assistance may be needed; and (e) to determine what impact the program is having on participants.[90] To assist states and localities in conducting evaluations of their education programs:

- The federal government, foundations and states should support the development, dissemination and adoption of user-friendly evaluation tools, including specifying the outcome measures they expect their grantees to measure (such as improvements in student achievement).

- The federal government, foundations and states should provide ongoing technical support to their grantees for conducting evaluations, setting high standards for the quality of evaluation information and reports.

- The federal government, foundations and states should make available on the Internet evaluation reports and studies on the use of technology in education so that researchers and evaluators can benefit from lessons learned.

➔ **Support the dissemination and use of research-based information to improve teaching and learning.** The effectiveness of technology in education is dependent upon how individual teachers employ it in their instruction. A national priority should be to ensure that teachers have access to useful and timely research-based information that can help them make appropriate decisions about how best to use technology with their students. Of equal importance, administrators and policymakers need access to rigorous research findings to make better decisions about how and where to make investments in technology-related equipment, materials and services. There are a number of actions that could help with the dissemination and use of research in education. For instance:

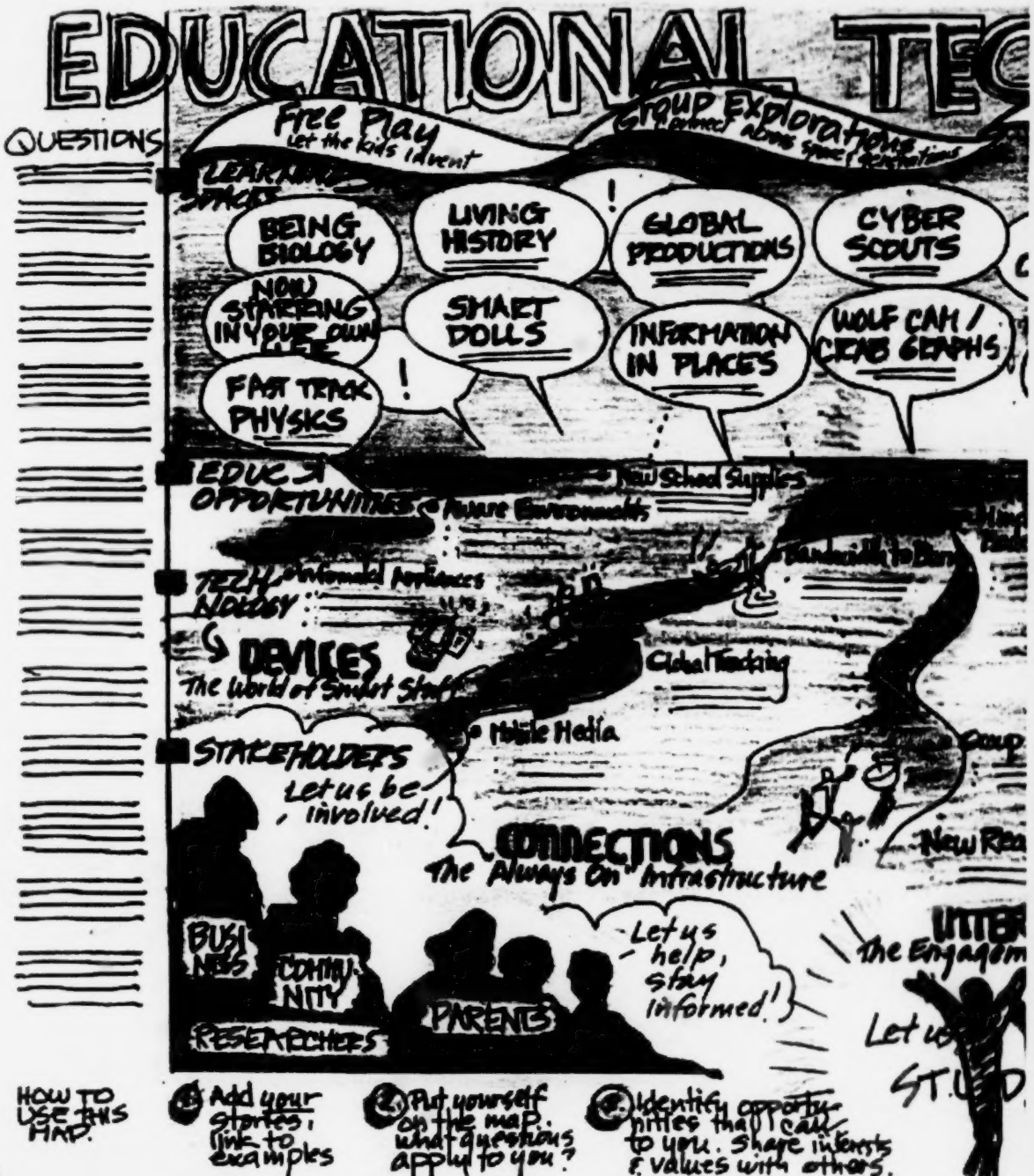
- The federal government, foundations, national associations and the private sector should convene national and regional conferences to bring researchers, educators, and policymakers together to discuss the implications of emerging research on technology in education.

- The results of research and evaluation should be synthesized and disseminated directly to states, districts and schools, or through national education associations.[91] The products of these research syntheses should be geared to the information needs of policymakers and practitioners.

- National, regional and state technical assistance centers should employ new online tools to provide research-based information to educators and policymakers. The Internet offers an unprecedented opportunity to dynamically share research-based information.

MAPPING THE EDUCATIONAL TECHNOLOGY HORIZON

In an effort to better understand emerging technologies, potential educational applications, challenges and success stories, The Grove Consultants International in collaboration with the Institute for the Future are developing an "Educational Technology Horizons Map" under a grant from the U.S. Department of Education. The map (depicted below) is a work-in-progress and should not be construed to advocate a particular solution or approach to using technology to improve teaching and learning; rather, it presents an array of possibilities.



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"SCHOOL LEADERS MUST WORK TO KEEP ABREAST OF ALL THE LATEST DEVELOPMENTS IN CURRICULUM AND DELIVERY OF THE NEW TECHNOLOGY TOOLS."

-CHERYL S. WILLIAMS, DIRECTOR, EDUCATION TECHNOLOGY PROGRAMS

NATIONAL SCHOOL BOARDS ASSOCIATION

5

Goal 5: Digital Content and Networked Applications Will Transform Teaching and Learning.

Digital content and networked applications will support transformative changes in our approaches to teaching and learning. In order for these changes to lead to increased educational opportunities for all students, digital content and networked applications must be independently judged to be of high quality (both in terms of grounding in learning science and pedagogical effectiveness), well-documented, comprehensive and available for all grades and subject areas, and have the power to inspire or motivate students. In addition, content and applications must be easy to find and access, easy for students and teachers to use, and accessible to people with disabilities.

Today, there exists tremendous opportunities for the creation of powerful digital content and networked applications. For instance, digital content and networked applications offer direct opportunities to enhance learning by helping students to comprehend difficult-to-understand concepts; helping students to engage in learning; providing students with access to information and resources; and better meeting students' individual needs. In addition, technology applications can increase parental involvement and improve the accountability and efficiency of school administration.

For many students, the lack of visual representation of many higher-order concepts makes learning them difficult. In this regard, teachers have been limited in what they can teach by the tools to which they have access. New technologies allow teachers to teach complex ideas and address intellectual challenges more easily. One example of this type of application is the Pump Algebra Tutor (PAT), which has been shown through studies to yield dramatic student achievement gains relative to control classes (15-25 percent better on standardized tests of basic skills and 50-100 percent better on assessments of problem solving and representation use). PAT is designed to help students to learn to model real-life problem situations using algebraic representations including tables, graphs, equations, and words.

Another promising use of technology in education involves teachers helping students to actively engage in learning, in helping students to learn by doing. In fact, the increasing power and versatility of computers create teaching and learning possibilities dramatically different from those that were previously available, providing teachers with the opportunity to enrich their instruction and students with the opportunity to contribute useful resources to others. Project-based learning—which is a model for classroom activity that shifts away from the classroom practices of short, isolated, teacher-centered lessons and instead emphasizes learning activities that are long-term, interdisciplinary, student-centered, and integrated with real world issues and practices—is one way in which technology can support teachers in helping students to engage in learning.

The GLOBE Program, for instance, brings together K-12 students, teachers, and scientists from around the world to help us learn more about the environment. By participating in GLOBE, teachers guide their students through daily, weekly, and seasonal environmental observations, such as air temperature and precipitation. Using the Internet, students send their data to the GLOBE Student Data Archive. Scientists and other students use this data for their research. Participating in

this program provides teachers an opportunity to integrate computers and the World Wide Web into classroom activities and to get students involved in hands-on science.

Another example is the ThinkQuest Internet Challenge. It is an international program for students, ages 12 through 19, that encourages them to use the Internet to create information-rich Web-based educational tools and materials. Students form teams with their colleagues from around the world and are mentored by teachers or other adult coaches. In the running for scholarships and awards totaling more than $1 million, student participants learn collaboration, leadership and critical thinking skills that help raise their level of education and technological expertise.

The Internet, more so than any technology that has preceded it, provides students with access to a vast array of information and resources far greater than could ever be provided within the four walls of a classroom. Creative uses of the Internet allow for the establishment of "virtual" communities of learners, collectives of teachers and students from literally around the world assembling to learn from each other and to tackle real-world problems. Today, students can compare how different U.S. and foreign newspapers cover the same international event. They can use primary resources in their research, such as the Harry S. Truman Library to study the Marshall Plan for an American history class. Students in astronomy courses can use images from professional telescopes along with image processing software developed for use in the classroom to pursue guided investigations of astronomical objects and phenomenon. Advanced placement (AP) and foreign language courses can be accessed over the Internet for students that do not have access to those classes in their own schools and districts.

One of the most powerful opportunities afforded education by technology is the opportunity to better meet students' individual learning needs. In addition to creating more engaging content, technology will allow better and more accurate assessments of what students know, where they are having difficulties, and how their teachers could best convey the knowledge and skills students need. Access to real-time tutoring will also increase, with opportunities being made available over the Internet. Importantly, in creating technologies that work better to meet students' individual needs, all students will benefit, including students with disabilities and students considered at-risk of school failure.

"THE NEXT BIG KILLER APPLICATION FOR THE INTERNET IS GOING TO BE EDUCATION. EDUCATION OVER THE INTERNET IS GOING TO BE SO BIG IT IS GOING TO MAKE E-MAIL USAGE LOOK LIKE A ROUNDING ERROR."

-JOHN T. CHAMBERS, CEO, CISCO SYSTEMS INC.

PROJECT LEMONLINK - LEMON GROVE SCHOOL DISTRICT, CALIFORNIA

An Innovative Approach to Bridging Home, School and Community.

LemonLINK is the hub for a connected learning community. The school district provides networking services for 8 schools and 16 other local government facilities including city hall, the fire department and community centers. LemonLINK extends well beyond the classrooms and community centers in to the homes providing high-speed Internet access and a wide variety of educational tools and learning resources to students at home and at school. With a federal Technology Innovation Challenge Grant, local investment, and high technology industry partnerships, local educators have built one of the most advanced district-wide networks in the nation.

A unique centralized network design allows the Lemon Grove School District to function as the applications service provider (ASP), offering 24 hour a day Internet access and applications to parents and students, community members, city government, community facilities, the parochial school and the local library. Working with business partners, LemonLINK has developed a low-cost network appliance that is used to connect student homes to the district Intranet via cable modem technology. The device has also enables a 1 to 2 computer to student ratio in every classroom and abundant access to a rich variety of learning resources via the Internet that vastly expands what is traditionally available in their own classroom, school and local library.

The positive impact of this extended curriculum, increased computer access and expanded time for learning is documented in gains in achievement by students in grades 3-8 who participated in the technology program. A recent two-year evaluation compared students who had access to technology and those who did not (in a random assignment of students). Gains were seen in both reading and mathematics achievement for the LemonLink Project students. In all of the comparisons, the LemonLINK students consistently exceeded those noted for the comparison students.

The long-term goals of the LemonLINK project are to bridge the digital divide by connecting all of the families in the district to the Internet and Intranet; to create a community-wide technology-based education environment; and to provide a comprehensive and continuing professional development program for educators at all levels.

Increasing parental involvement in their children's education through technology represents another promising opportunity. In fact, existing technologies can help address what is perhaps the largest barrier to family involvement in education: a lack of time. The increase in the number of single-parent households, those with dual income earners, and those with parents working more than one job, has led to a sharp decline in how much time is spent helping children with their education. Technologies such as voicemail and easy to use Web sites offer parents new ways of communicating with their children's schools.[22]

By integrating disparate sources of information on the performance and operation of schools, technology also offers opportunities to improve the accountability and efficiency of school administration. Networked applications will allow appropriate individuals to access up-to-date information, through the Web, on every important aspect of schooling, from trends in attendance, test scores, finances and student demographics. Through technology, parents—for the first time—will be able to track the real-time progress and performance of their children's schools on a daily basis. In addition, these applications will allow for reductions in administrative overhead and free-up resources and teacher time to support student learning.

To ensure that digital content and networked applications will transform teaching and learning, we should:

- **Ensure administrators and policymakers are technologically literate.** Technologically literate education leaders will be the agents of educational reform and improvement in the 21st century. The best of all leaders will possess instructional leadership and effective management and communication skills, as well as a comfort with and knowledge of technology. Demonstrated technological literacy will ensure that administrators and policymakers will be able to articulate and implement plans to effectively harness the information age for education in their schools. To ensure administrators and policymakers are technologically literate, states and districts should provide professional development opportunities for state and local administrators and policymakers so that they are well-prepared to make decisions about the use of technology for improved teaching and learning, as well as provide administrators and policymakers with sufficient time to take advantage of professional development opportunities. In addition, the private sector and national education associations should develop materials and tools to help administrators and policymakers to become technologically literate.

MISSISSIPPI STATE DEPARTMENT OF EDUCATION

Technology Standards for Administrators

While national organizations, states and local entities have begun to establish technology standards for teachers and students, few have yet addressed technology standards for administrators and policymakers. Mississippi is one of the first states to implement technology standards for education administrators. These are:

Standard 1 - Vision: Communicates to all stakeholders a vision of the role of technology in teaching and learning.

Standard 2 - Funding and Long-Range Planning: Develops, implements, and monitors a long-range technology plan.

Standard 3 - Professional Development: Initiates and supports professional development processes that produce effective uses of technology in teaching and learning.

Standard 4 - Model User: Models the effective use of technology in support of teaching, learning, and administrative functions.

Standard 5 - Learning Environment: Creates a learning environment that empowers staff to infuse technology into teaching and learning.

Standard 6 - Student Learning: Ensures the implementation of district, school, and classroom strategies that prepare students to be successful in a technological world.

Standard 7 - Legal, Ethical, and Security Issues: Communicates the legal, ethical, and security issues related to technology.

Source: http://e2t.msde.k12.ms.us/tastis/administ.standards.html

- **Support efforts to increase our understanding of how to improve teaching and learning through partnerships within and across sectors.** To realize improvements in teaching and learning enabled by technology requires increased collaboration within education, as well as a need for policymakers, administrators and teachers to seek expertise from regional, state and local external partners. These partners include businesses, postsecondary education institutions, libraries, museums and other community-based organizations and associations. Specific strategies include:

  - Hosting conferences and meetings that bring together educators, researchers, private sector experts and others to increase dialogue on how to improve teaching and learning through technology.

  - Establishing partnerships among states, districts and schools and other organizations and entities who have not traditionally been involved in educational matters to help increase our understanding of how to improve teaching and learning.

  - Forming independent organizations at the national, regional, state and local levels to solidify ongoing partner commitment and build the likelihood of continued involvement.

  - Establish innovative partnerships to jointly fund projects to develop new technology-based products and services.

- **Identify leadership opportunities provided by technology to offer better ways of accomplishing educational goals.** In creating more effective schools, we have been constrained both by our imagination of what is possible and by the power of our learning tools. New technological tools—enabled by innovations in the learning environment—give us a chance to create rich and diverse learning resources, such as graphic and simulation tools, that are fully accessible to all. The delivery of education and related services over the Internet offers the possibility to rethink teaching and learning, from educational resource materials and content to assessment and tutoring. Other areas ripe for innovation include ways of establishing collaborations among schools, libraries, museums, higher education and industry; evaluating the quality of educational materials and content; and archiving public domain historical, cultural and scientific resources. More specifically:

  - States, districts and national education organizations and associations should partner or enter licensing agreements with educational content and related service providers;

  - The federal government, states, districts and national education organizations and associations should commit to creating and using tools to digitize and share existing resources (e.g., videos of effective teaching or teacher lesson plans aligned to existing standards); and

  - The federal government, states, districts and national education organizations and associations should form "incubators" to develop promising new ideas and ventures for education and commit resources to help bring to fruition the ideas with the greatest potential for education.

- **Continue and expand efforts to digitize rich educational materials consistent with copyright laws.** As access to the Internet becomes universal, it becomes increasingly important to ensure that information heretofore only available in public libraries, museums and federal, state, and local government offices also be available online and in digital formats. The American Memory Project of the Library of Congress is but one exemplary example, as is the work of NASA and other governmental resources. The continuation and expansion of projects like Federal Resources for Educational Excellence (FREE), which contains hundreds of federally supported education resources from over 30 federal agencies, will contribute to this effort. In continuing and expanding these efforts, it is essential to link our efforts with those of other countries to help build awareness and understanding of other cultures to all our learners.

- **Encourage the aggregation of demand for resources and services to attract better and more effective technology-based services for improved teaching and learning.** The economics of developing high-quality interactive content require large up-front investments of time and resources, while the costs associated with distribution of such content once it has been produced are trivial. To encourage the development of high-quality digital content and

"THE ORGANIZATION OF SCHOOL WILL BE DIFFICULT TO CHANGE. ULTIMATELY, WE NEED TO THINK ABOUT NEW WAYS OF ASSESSING AND DOCUMENTING COMPETENCE, MUCH OF WHICH MAY BE SUPPORTED BY TECHNOLOGY IN ORDER TO FREE UP EDUCATIONAL ORGANIZATIONS AND STRUCTURES TO TRY NEW METHODS TO MEET THE GOALS OF EDUCATION. THIS WILL BE A TECHNOLOGY-BASED, MORE FAR-RANGING VERSION OF THE CURRENT EXCHANGE OF FLEXIBILITY FOR ACCOUNTABILITY SEEN IN CHARTER SCHOOLS.

-PARTICIPANT, FORUM ON TECHNOLOGY IN EDUCATION: ENVISIONING THE FUTURE

networked applications, state and local agencies—as well as national education associations and organizations—should experiment with ways of aggregating purchasing power (e.g., through statewide licensing, multi-state RFPs, etc.). In so doing, content developers can be encouraged to make the large up-front investments of time and resources required to develop high-quality interactive content.

- **Support educators and technologists in defining what digital content and networked applications should be available to support teaching and learning.** Many recent efforts to develop curriculum materials by states, districts, content publishers, and national education associations and organizations are disconnected with initiatives to develop high-quality digital content and networked applications. As access to technology is reaching a critical mass in schools, classrooms, homes and communities, the technical and practical reasons for this disconnect fall away. It is becoming increasingly important to ensure that powerful curricular materials be migrated to technology-based platforms in ways that take unique advantage of the more powerful medium. As a first step in this process, educators and technologists can define what digital content and networked applications should be available to support teaching and learning.

- **Remove barriers to purchasing digital content and networked applications.** To best take advantage of the opportunities provided by high-quality digital content and networked applications, states and districts should review their financial model for technology—including hardware, connectivity, professional development, and digital content—and identify opportunities to leverage existing resources and target new ones. Among other actions, school systems should ensure that instructional materials budgets are available to purchase the most appropriate content to meet educational objectives. This becomes critically important as many Internet business models that provide educational content and resources for free are not sustainable.

- **Recognize developers of high-quality digital content and networked applications and exemplary adoption of educational technologies.** It is important to create incentives to support the development and innovative use of high-quality digital content and networked applications. Universities should provide academic/career recognition—recognition that influences tenure decisions—to professors that develop high-quality online learning resources. The U.S. Department of Education should continue and expand its expert panel program, recognizing exemplary and promising technology programs accord-

ing to rigorous criteria. Competitions, such as those sponsored by ThinkQuest, encourage students to take part in content development activities. Awards by technology industry groups, such as the Software & Information Industry Association and Nelson Heller and Associates, encourage the development of high-quality digital content and networked applications for improved teaching and learning.

→ **Support the integration of digital content and networked applications into state and local standards and curricular frameworks.** Student learning is enhanced by digital content and networked applications when it is integrated into state and local standards and curricular frameworks for what students should know and be able to do. States and districts should support technology coordinators and teachers in identifying appropriate technology resources for their students. The federal government should allow the use of funds from programs such as the Technology Literacy Challenge Fund for activities to integrate digital content and resources into classroom instruction.

CONCLUSION

Today, it is evident that school improvement programs that employ technology for teaching and learning yield positive results for students and teachers. In addition, the adoption of new and emerging technologies by schools and classrooms offers even more reason to be hopeful. With sufficient access and support, teachers will be better able to: help their students to comprehend difficult-to-understand concepts and engage in learning; provide their students with access to information and resources; and better meet their students' individual needs. In addition, technology applications can increase parental involvement and improve the accountability and efficiency of school administration. Indeed, if we take advantage of the opportunities presented to us, technology will enhance learning and improve student achievement for *all* students.

The use of technology in education must remain a national priority. It must be at the core of the educational experience, not at the periphery. Looking forward, we should ensure that:

- All students and teachers will have access to information technology in their classrooms, schools, communities and homes.
- All teachers will use technology effectively to help students achieve high academic standards.
- All students will have technology and information literacy skills.
- Research and evaluation will improve the next generation of technology applications for teaching and learning.
- Digital content and networked applications will transform teaching and learning.

The leadership imperative is clear. Collectively, these new goals for technology in education represent an updated, high-level strategy for ensuring the future of education in which all students will benefit from the enhanced learning opportunities afforded by new and emerging communications and information technologies.

APPENDICES

A. The Process of Developing *e-Learning*

B. Contributors

C. Endnotes

APPENDIX A

The Process of Developing *e-Learning*

In the fall of 1999, the U.S. Department of Education's Office of Educational Technology (OET) initiated the strategic process of revising the national educational technology plan, *Getting America's Students Ready for the 21st Century: Meeting the Technology Literacy Challenge*. This effort was necessary to address the tremendous progress that had occurred toward achieving the initial four goals, as well as the continuing advances in the capabilities of technology. In addition to reviewing current literature and data, the Department solicited input from researchers, policymakers, educators, practitioners, administrators, parents and students interested in the future of technology in education.

OET commissioned four white papers to explore different perspectives on the future of technology in education. In addition, five papers were commissioned to examine the relationship between content and technology in the following areas—social studies, science, mathematics, the arts, and reading and language arts. Together, these white papers informed discussions at the *Forum on Technology in Education: Envisioning the Future*, which was held December 1-2, 1999 at Georgetown University in Washington, D.C.

The Forum on Technology in Education: Envisioning the Future explored the need to revise the national educational technology plan, generate emerging priorities for the future of technology in education, and identify creative strategies to improve teaching and learning for all students through the effective use of technology. The participants included technology futurists, educators and students, content experts, business and government representatives. Grove Consultants International and CoVision, Inc. assisted in the success of the *Forum* through expert graphics facilitation and GroupWare technology.

Following the Forum, OET launched a web site, *Revising the 1996 National Educational Technology Plan* (http://ed.gov/Technology/). The site includes the white papers, background information on the *Forum* (including the agenda, participant biographies, graphic notes, and the synthesis report of the *Forum*), summaries of online input, emerging priorities, and the 1996 National Educational Technology Plan.

OET also hosted an online forum to solicit comments on the emerging priorities. The public—including educators, students, administrators, policymakers, parents, family members and other concerned citizens—was encouraged to submit their opinions on access to technology; teachers and technology; students and technology; educational technology research and development; and e-Learning and education. Online comment periods began on April 17, 2000 and concluded May 19, 2000.

On June 13, 2000, the Office of Educational Technology hosted an Internet-based "Kids Chat" to discuss the issues important to students and the future of technology in education. This interactive online discussion provided insight by children from around the country. K12nation.net hosted the "Kids Chat" event.

The 21st annual National Educational Computing Conference (NECC) served as an invaluable gathering of people interested in the future of technology in education. OET sought input on strategies for addressing the emerging priorities from a number of sessions held in conjunction with NECC. The International Society for Technology in Education (ISTE) hosted a Leadership Forum during which participants shared input on the goals and helped to identify innovative strategies for achieving the goals. A Technology Innovation Challenge Grantee, Education for a Sustainable Future (Cobb County, GA), hosted a Teachers' Forum to test the goals and strategies before an audience of several hundred educators. OET also had the opportunity to solicit feedback on the goals and strategies from more than twenty state technology directors.

OET participated in numerous conferences and forums across the country to solicit input on the development of *e-Learning*. Given the complementary work of the Web-based Education Commission, OET held meetings with their staff, attended the Commission hearings and reviewed testimony submitted to the Commission. OET also presented the new goals to the TechNet Board of Directors in California and numerous national education and technology groups in Washington, D.C.

OET reviewed all of the invaluable input received from across the country in developing *e-Learning: Putting a World-Class Education at the Fingertips of All Children*. It is our expectation that *e-Learning* will help to guide all education stakeholders in increasing the effective use of technology for teaching and learning.

APPENDIX B
Contributors

Carole Wacey, U.S. Department of Education, and Douglas Levin, American Institutes for Research, directed the development of *e Learning: Putting a World-Class Education at the Fingertips of All Children*. *e Learning* is the culmination of input from countless numbers of people who contributed their time and ideas to its development. We have highlighted many of those people here.

Tom Abeles, On the Horizon
Kay Abernathy, Brazos-Sabine Connection
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APPENDIX C
Endnotes

U.S. Department of Education (1996). *Getting America's Students Ready for the 21st Century: Meeting the Technology Literacy Challenge*. Washington, D.C. http://www.ed.gov/Technology/Plan/NatTechPlan

Bransford, J., Brown, A., Cocking, R., and Bransford, J. (Eds.) (1999). *How People Learn: Brain, Mind, Experience, and School*. Washington, D.C.: National Academy Press.

Rose, L., and Gallup, A. (2000). "The 32nd Annual Phi Delta Kappa/Gallup Poll of the Public's Attitudes Toward the Public Schools." Phi Delta Kappan, September, pp. 41-58.

Rose, D., and Meyer, A. (2000). *The Future Is in the Margins: The Role of Technology and Disability in Educational Reform*. White paper prepared for the U.S. Department of Education, Office of Educational Technology. Forum on Technology in Education: Envisioning the Future. Washington, D.C. http://www.air.org/forum/AbRose_Meyer.htm

The CEO Forum on Education and Technology (1999). *Professional Development: A Link to Better Learning*. The CEO Forum School Technology and Readiness Report – Year Two. Washington, D.C.

U.S. Department of Education, National Center for Education Statistics (1995). *Schools and Staffing Survey, 1993-1994*. Washington, D.C.: U.S. Department of Education; McKinsey & Co. (1995). *Connecting K-12 Schools to the Information Superhighway*. Palo Alto, Calif.: McKinsey & Company.

Office of Technology Assessment (1995). *Teachers and Technology: Making the Connection*. OTA-EHR-616. Washington, D.C. http://www.wws.princeton.edu/~ota/disk1/1995/9541.html

U.S. Department of Education, National Center for Education Statistics (2000a). *Teachers' Tools for the 21st Century: A Report on Teachers' Use of Technology*. NCES 2000-102, by Becky Smerdon, Stephanie Cronen, Lawrence Lanahan, Jennifer Anderson, Nicholas Iannotti, and January Angeles. Washington, D.C. http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2000102

U.S. Department of Education, National Center for Education Statistics (2000a). *Ibid.*

U.S. Department of Education, National Center for Education Statistics (2000b). *Teacher Use of Computers and the Internet in Public Schools*. NCES 2000-090, by Cassandra Rowand. Washington, D.C. http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2000090

U.S. Department of Education, National Center for Education Statistics (2000a). *Ibid.*

Solomon, L. and Wiederhorn, J. (2000). *Progress of Technology in the Schools: 1999 – Report on 27 States*. *Milken Exchange on Education and Technology*. Milken Family Foundation. Santa Monica, Calif.: Milken Family Foundation.

The CEO Forum on Education and Technology (2000a). *Teacher Preparation StaR Chart: A Self-Assessment Tool for Colleges of Education – Preparing a New Generation of Teachers*. Washington, D.C.

The CEO Forum on Education and Technology (2000a). *Ibid.*

See http://www.ceoforum.org/scde-commitments.cfm for an up-to-date status report of the names and numbers of institutions that have committed to improving their teacher preparation programs by employing the CEO Forum on Education and Technology's STaR chart.

U.S. Department of Education, National Center for Education Statistics (2000c). *Internet Access in U.S. Public Schools and Classrooms: 1994-1999*, NCES 2000-086, by Catrina Williams. Washington, D.C. http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2000086; U.S. Department of Education, National Center for Education Statistics (2000b). *Ibid.*

U.S. Department of Education, National Center for Education Statistics. (2000a). *Ibid.*

U.S. Department of Education, National Center for Education Statistics (2000c). *Ibid.*

Chow, C., Ellis, J., Mark, J., and Wise, B. (1998). *Impact of CTCNet Affiliates: Findings from a National Survey of Users of Community Technology Centers*. Education Development Center. Newton, Mass. http://www.ctcnet.org/impact98.htm

U.S. Department of Education, National Center for Education Statistics. (2000a). *Ibid.*

BEST COPY AVAILABLE

[i] U.S. Department of Education, National Center for Education Statistics. (2000a). *Ibid.*

President's Committee of Advisors on Science and Technology (PCAST), Panel on Educational Technology (1997). *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States.* http://www.whitehouse.gov/WH/EOP/OSTP/NSTC/PCAST/k-12ed.html

[ii] U.S. Department of Education, National Center for Education Statistics (2000a). *Ibid.*

[iii] Anderson, R. and Ronnkvist, A. (1999). *The Presence of Computers in American Schools.* Teaching, Learning, and Computing: 1998 National Survey Report #2. Center for Research on Information Technology and Organizations. The University of California, Irvine and The University of Minnesota. http://www.crito.uci.edu/tlc/findings/computers_in_american_schools

[iv] U.S. Department of Education, National Center for Education Statistics (2000a). *Ibid.*

[v] Analyses of US Census Bureau data.

[vi] Harvey, J. (ed.) (1995). *The Market for Educational Software.* Prepared for Office of Educational Technology, U.S. Department of Education. Santa Monica, Calif.: Critical Technologies Institute, RAND.

[vii] U.S. Department of Education, National Center for Education Statistics (2000a). *Ibid.*

[viii] U.S. Department of Education, National Center for Education Statistics (2000a). *Ibid.*

[ix] Ronnkvist, A., Dexter, S., and Anderson, R. (2000). *Technology Support: Its Depth, Breadth and Impact in America's Schools.* Teaching, Learning, and Computing: 1998 National Survey Report #5. Center for Research on Information Technology and Organizations. The University of California, Irvine and The University of Minnesota. http://www.crito.uci.edu/tlc/findings/technology-support: U.S. Department of Education, National Center for Education Statistics (2000a). *Ibid.*

[x] Education Week and The Milken Exchange on Education Technology (September 23, 1999). *Technology Counts '99 Building the Digital Curriculum.* Volume XIX (4). Editorial Projects in Education. Bethesda, Md. http://www.edweek.org/sreports/tc99

[xi] U.S. Department of Education, National Center for Education Statistics (2000a). *Ibid.*

[xii] U.S. Department of Education, National Center for Education Statistics (2000a). *Ibid.*

[xiii] The CEO Forum on Education and Technology (2000b). *The Power of Digital Learning: Integrating Digital Content.* School Technology and Readiness Report – Year 3. Washington, D.C. http://www.ceoforum.org/downloads/report3.pdf

[xiv] Lesgold, A., and Reif, F. (1983). *Computers in Education: Realizing the Potential.* Report of a Research Conference, Pittsburgh, Pa., November 20-24, 1982. Prepared for the U.S. Department of Education, Office of Educational Research and Improvement.

[xv] For example: Kulik, J. (1994). "Meta-Analytic Studies of Findings on Computer-Based Instruction." In Baker, E., and O'Neil, H. (Eds.) *Technology Assessment in Education and Training.* Hillsdale, NJ: LEA Publishers; Follansbee, S. (1996). *The Role of Online Communications in Schools: A National Study.* Peabody, Mass.: Center for Applied Special Technology; The Software and Information Industry Association (SIIA) (2000). *2000 Report on the Effectiveness of Technology in Schools.* Washington, D.C.: SIIA.

[xvi] Silverstein, G., Frechtling, J., and Miyaoka, A. (2000). *Evaluation of the Use of Technology in Illinois Public Schools: Final Report.* Prepared for Research Division, Illinois State Board of Education. Rockville, Md.: Westat.

[xvii] The Milken Exchange on Education and Technology (2000). *Miami Dade County Public Schools Assessment Study: 1999-2000.* Santa Monica, Calif.: The Milken Family Foundation.

[xviii] Xin, J. (1999). "Computer-Assisted Cooperative Learning in Integrated Classrooms for Students with and without Disabilities." *Information Technology in Childhood Education*, 61-78.

[xix] Idaho Council for Technology in Learning (1999). *The Idaho Technology Initiative: An Accountability Report to the Idaho Legislature on the Effects of Monies Spent through the Idaho Council for Technology in Learning.* Idaho: The State Division of Vocational Education, The State Department of Education, Bureau of Technology Services.

[xx] Mann, D., Shakeshaft, C., Becker, J., and Kottkamp, R. (1999). *West Virginia Story: Achievement and Gains from a Statewide Comprehensive Instructional Technology Program.* Santa Monica, Calif.: The Milken Family Foundation.

BEST COPY AVAILABLE

[41] Wenglinsky, H. (1998). *Does it Compute? The Relationship Between Educational Technology and Student Achievement in Mathematics.* A Policy Information Report. Princeton, N.J.: Educational Testing Service. ftp://etsis1.ets.org/pub/res/technolog.pdf

[42] Birenbaum, H., and Kornblum, W. (1998). *Project TELL Telecommunications for Learning - Report of a Seven-Year Study to Bell Atlantic.* New York: The Stanton/Heiskell Center for Public Policy in Telecommunications and Information Systems.

[43] Henriquez, A., and Risconscente, M. (1998). *Rhode Island Teachers and Technology Initiative: Findings from the Pilot Year.* New York: EDC Center for Children and Technology.

[44] Liu, M. (1998). "The effect of hypermedia authoring on elementary school students' creative thinking." *Journal of Education Computing Research*, 1(19), 27-51.

[45] Chang, H., Henriquez, A., Honey, M., Light, D., Moeller, B., and Ross N. (1998). *The Union City Story: Education Reform and Technology - Students' Performance on Standardized Tests.* New York: EDC Center for Children and Technology.

[46] Linn, M., Bell, P., and His, S. (1998). "Using the Internet to Enhance Student Understanding of Science: The Knowledge Integration Environment." *Interactive Learning Environments*, 1(6), 4-38.

[47] Owston, R. and Wideman, H. (1997). "Word processors and children's writing in a high-computer access setting." *Journal of Research on Computing in Education*, 30(2), 202 - 220.

[48] Follansbee, S. (1996). *Ibid.*

[49] Bransford, J., Brown, A., Cocking, R., and Bransford, J. (Eds.) (1999). *Ibid.*

[50] Bransford, J., Brown, A., Cocking, R., and Bransford, J. (Eds.) (1999). *Ibid.*

[51] Labbo, L. (1999). *Toward a Vision of the Future Role of Technology in Literacy Education.* White paper prepared for the U.S. Department of Education, Office of Educational Technology, Forum on Technology in Education: Envisioning the Future, Washington, D.C. http://www.air.org/forum/Labbo.pdf

[52] Rubin, A. (1999). *Technology Meets Math Education: Envisioning A Practical Future.* White paper prepared for the U.S. Department of Education, Office of Educational Technology, Forum on Technology in Education: Envisioning the Future, Washington, D.C. http://www.air.org/forum/Rubin.pdf

[53] Rubin, A. (1999). *Ibid.*

[54] Assey, J. (1999). *The Future of Technology in K-12 Arts Education.* White paper prepared for the U.S. Department of Education, Office of Educational Technology, Forum on Technology in Education: Envisioning the Future, Washington, D.C. http://www.air.org/forum/Assey.pdf

[55] The CEO Forum of Education and Technology (2000b). *Ibid.*

[56] Rakow, S. (1999). *Forum on Technology in K-12 Education: Envisioning a New Future—Science.* White paper prepared for the U.S. Department of Education, Office of Educational Technology, Forum on Technology in Education: Envisioning the Future, Washington, D.C. http://www.air.org/forum/abRakow.htm

[57] The CEO Forum on Education and Technology (2000b). *Ibid.*

[58] Assey, J. (1999). *Ibid.*

[59] The CEO Forum on Education and Technology (2000b). *Ibid.*

[60] The CEO Forum on Education and Technology (2000b). *Ibid.*

[61] Bass, R., and Rosenzweig, R. (1999). *Rewiring The History And Social Studies Classroom: Needs, Frameworks, Dangers, And Proposals.* White paper prepared for the U.S. Department of Education, Office of Educational Technology, Forum on Technology in Education: Envisioning the Future, Washington, D.C. http://www.air.org/forum/Bass.pdf

[62] Rakow, S. (1999). *Ibid.*

[63] Bass and Rosenzweig (1999). *Ibid.*

[64] Bransford, J., Brown, A., Cocking, R., and Bransford, J. (Eds.) (1999). *Ibid.*

[65] Rubin, A. (1999). *Ibid.*

[66] Bransford, J., Brown, A., Cocking, R., and Bransford, J. (Eds.) (1999). *Ibid.*

[67] Bennett, R. (forthcoming). *"How the Internet Will Help Large-Scale Assessment Reinvent Itself."* in M. Rabinowitz, F.C. Blumberg, and H. Everson (Eds.), The Impact of Media and Technology on Instruction. Hillsdale, N.J: Erlbaum.

BEST COPY AVAILABLE

[43] Russell, M. (2000). *It's Time to Upgrade: Tests and Administration Procedures for the New Millennium*. White paper prepared for the U.S. Department of Education, Office of Educational Technology. The Secretary's Conference on Educational Technology 2000. Washington, D.C. http://www.ed.gov/Technology/techconf/2000/russell_paper.html

[44] See Appendix A for more information on how this plan was developed.

[45] Organization for Economic Cooperation and Development (OECD) (2000). *Education Policy Analysis: 1999 Edition*. Paris, France: OECD.

[46] Cohen, D. (July 14, 2000). "Hong Kong's Boom in Distance Education May Be a Sign of What's to Come in Asia." *Chronicle of Higher Education*.

[47] For example, Mooney, P. (July 13, 2000). "China Plans to Expand Distance Education in Western Regions." Chronicle of Higher Education; Overland, M. (July 14, 2000). "India Uses Distance Education to Meet Huge Demand for Degrees." *Chronicle of Higher Education*.

[48] U.S. Department of Education, National Center for Education Statistics (2000d). *Condition of America's Public School Facilities: 1999*, NCES 2000-032, by Laurie Lewis, Kyle Snow, Elizabeth Farris, Becky Smerdon, Stephanie Cronen, Jessica Kaplan, and Bernie Greene. Washington, D.C. http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2000032

[49] U.S. Department of Education, National Center for Education Statistics (2000d). *Ibid.*

[50] American Council on Education (1999). *To Touch the Future: Transforming the Way Teachers Are Taught: An Action Agenda for College and University Presidents*. Washington, D.C.: The CEO Forum on Education and Technology (2000a). *Ibid:* The CEO Forum on Education and Technology (1999). *Professional Development: A Link to Better Learning*. The CEO Forum School Technology and Readiness Report. Year 2. Washington, D.C. http://www.ceo-forum.org/downloads/99report.pdf; Moursand, D., and Bielefeldt, T. (1999). *Will New Teachers Be Prepared to Teach in a Digital Age? A National Survey on Information Technology in Teacher Education*. Santa Monica, Calif.: Milken Family Foundation. Milken Exchange on Education Technology; The National Commission on Mathematics and Science Teaching for the 21st Century (2000). *Before It's Too Late*. A Report to the Nation from the National Commission on Mathematics and Science Teaching for the 21st Century. Washington, D.C.: U.S. Department of Education. http://www.ed.gov/inits/Math/glenn; National Council for Accreditation of Teacher Education (NCATE) (1997). *Technology and the New Professional Teacher: Preparing for the 21st Century Classroom*. Task Force on Technology and Teacher Education. Washington, D.C.: NCATE.

[51] See the International Society for Technology in Education's *National Educational Technology Standards (NETS) for Teachers Project* at: http://cnets.iste.org/index3.html

[52] U.S. Department of Education (1998). *Promising Practices: New Ways to Improve Teacher Quality*. Washington, D.C. http://www.ed.gov/pubs/PromPractice/index.html

[53] U.S. Department of Education, National Center for Education Statistics (2000e). *Projections of Education Statistics to 2010*, NCES 2000-071, by Debra Gerald and William Hussar. Washington, D.C. http://nces.ed.gov/pubs2000/2000071.pdf

[54] U.S. Department of Education (1998). *Ibid.*

[55] U.S. Department of Commerce (1999). *The Emerging Digital Economy II*. By David Henry, Patricia Buckley, Gurmukh Gill, Sandra Cooke, Jess Dumagan, Dennis Pastore, and Susan LaPorte. Washington, D.C. http://www.ecommerce.gov/ede/ede2.pdf

[56] Eisenberg, M., and Johnson, D. (1996). *Computer Skills for Information Problem-Solving: Learning and Teaching Technology in Context*. EDO-IR-96-04. Syracuse, NY: ERIC Clearinghouse on Information & Technology. http://ericir.syr.edu/ithome/digests/computerskills.html

[57] Eisenberg, M., and Johnson, D. (1996). *Ibid.*

[58] 21st Century Workforce Commission (2000). *A Nation of Opportunity: Building America's 21st Century Workforce*. Washington, D.C.: 21st Century Workforce Commission.

[59] International Technology in Education Association (ITEA) (2000). *Standards for Technological Literacy: Content for the Study of Technology*. Reston, Va.: ITEA.

[60] Healy, J. (1998). *Failure to Connect: How Computers Affect Our Children's Minds—for Better and Worse*. New York: Simon & Schuster; Cordes, C., and Miller, E. (eds.) (2000). *Fool's Gold: A Critical Look at Computers in Childhood*. College Park, Md.: Alliance for Childhood. http://www.allianceforchildhood.net/projects/computers/computers_reports.htm

[61] Commission on Child Online Protection (2000). *Report to Congress*. Washington, D.C. http://www.copacommission.org/report

[62] The National Commission on Mathematics and Science Teaching for the 21st Century (2000). *Ibid.*

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[vi] For example: Fouts, J. (2000). *Research on Computers and Education: Past, Present and Future*. Seattle, Wash.: Bill and Melinda Gates Foundation. http://www.gatesfoundation.org/learning/education/executivesummary.pdf; PCAST (1997). *Ibid.*; Bransford, J., Brown, A., Cocking, R., and Bransford, J. (Eds.) (1999). *Ibid.*

[vii] Quinones, S. and Kirshstein, R. (1998). *An Educator's Guide to Evaluating the Use of Technology in Schools and Classrooms*. Prepared for U.S. Department of Education, Office of Educational Research and Improvement. Washington, D.C. http://www.ed.gov/pubs/EdTechGuide/

[viii] One promising approach to synthesizing research-based information for education policy and practice is the Campbell Collaboration. The Campbell Collaboration is an emerging international effort that aims to help people make well-informed decisions by preparing, maintaining, and promoting access to systematic reviews of studies on the effects of social and educational policies and practices. See http://campbell.gse.upenn.edu/index.html for more information.

[ix] Otterbourg, S. (1998). *Using Technology to Strengthen Employee and Family Involvement in Education*. Research Report 1223-98-RR. New York: The Conference Board.

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HIGHLIGHTS DURING THE CLINTON ADMINISTRATION

1993 - 2000

1993

- Executive Order #12881: National Science and Technology Council
- Executive Order #12882: President's Committee of Advisors on Science and Technology (PCAST)
- Federal Information Infrastructure Task Force
- U.S. Advisory Council on the National Information Infrastructure

1994

- **Goals 2000: Educate America Act: Creates the U.S. Department of Education's Office of Educational Technology**
- **Improving America's Schools Act, Title III: Technology for Education Act**
- **Vice President Gore proposes national telecommunications reform and connecting every classroom and library to the Internet.**
- **In State of the Union Address, President Clinton challenges the nation to connect every classroom to the Internet.**
- All states receive state technology planning grants under Goals 2000.
- Regional Technology in Education Consortia (R*TEC)
- U.S. Department of Commerce, Telecommunications and Information Infrastructure Assistance Program (TIIAP) [later becomes Technology Opportunities Program (TOP)]
- Secretary Riley's First Conference on Educational Technology: Pathways to Learning Communities: Connecting Education to the Information Superhighway
- U.S. Department of Education Satellite Town Meeting: Learning On-Line
- U.S. Department of Commerce, National Institute of Standards and Technology: *Putting the Information Infrastructure to Work: A Report of the Information Infrastructure Task Force's Committee on Applications and Technology*

1995

- **President Clinton convenes CEO Roundtable and challenges industry and educators to work together on educational technology; he launches the Technology Innovation Challenge Grants; and he announces the American Technology Honor Society and TechCorps.**
- Federal Networking Council is chartered by the National Science and Technology Council
- Secretary Riley's Second Conference on Educational Technology: Making It Happen
- U.S. Department of Education's Conferences on Improving America's Schools: Institute on Meeting the Technology Literacy Challenge
- U.S. Department of Education/Rand Corporation Workshops: Technology and Teacher Professional Development; Planning and Financing Educational Technology; The Market for Educational Software; The Costs and Effectiveness of Educational Technology
- U.S. Department of Education Satellite Town Meeting: Linking Schools to the Future
- The White House Education Technology Forum for Education and Business Leaders
- **U.S. Department of Education, National Center for Education Statistics: *Advanced Telecommunications in U.S. Public Schools, K-12***
- Congressional Office of Technology Assessment: *Teachers and Technology: Making the Connection*
- National Academy of Science and the National Academy of Engineering: *Reinventing Schools: The Technology Is Now!*
- U.S. Department of Commerce: *Falling Through the Net: A Survey of the "Have Nots" in Rural and Urban America*
- U.S. Department of Education, Office of Educational Technology: *The Future of Networking Technologies for Learning*

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→ MILESTONES ■ LEGISLATION ■ EXECUTIVE ORDERS ■ COMMISSIONS ■ NATIONAL INITIATIVES

1996

President Clinton signs the Telecommunications Act of 1996 into law and the Federal Communications Commission, Federal-State Joint Board on Universal Service recommends K-12 school discounts on telecommunications services (E-rate).

- Executive Order #12999: Educational Technology: Ensuring Opportunity For All Children in the Next Century. Created Computers for Learning (federal computer donations) and encouraged federal employees to volunteer in schools

President Clinton issues the Technology Literacy Challenge to achieve the four national education goals and creates the Technology Literacy Challenge Fund—a five-year, $2 billion commitment to build capacity in the states.

NetDay: President Clinton, Vice President Gore and Cabinet officials wire schools in California. This is followed by Net Days across the nation.

- 21st Century Teachers Network
- CEO Forum on Education and Technology
- CyberEd Truck travels to Empowerment Zones
- Education and Library Networks Coalition (EdLiNC)

- G-7 Ministerial Conference on the Information Society
- U.S. Department of Education's Conferences on Improving America's Schools: Institute on Connecting Classrooms to the Information Superhighway
- U.S. Department of Education Satellite Town Meeting: Technology and Teacher Leadership for 21st Century Teachers

U.S. Department of Education, Office of Educational Technology, National Educational Technology Plan: *Getting America's Students Ready for the 21st Century: Meeting the Technology Literacy Challenge*

- National Governors' Association: *Technology and Education Standards*
- U.S. Advisory Council on the National Information Infrastructure: *Final Report to the President*
- U.S. Advisory Council on the National Information Infrastructure: *KickStart Initiative: Connecting America's Communities to the Information Superhighway*
- U.S. Department of Education, National Center for Education Statistics: *Advanced Telecommunications in U.S. Public Elementary and Secondary Schools, 1995*
- U.S. Department of Education/Rand Corporation:. *Fostering the Use of Educational Technology: Elements of a National Strategy*

1997

Federal Communications Commission votes unanimously to provide all K-12 schools and libraries discounts on telecommunications services (E-rate).

- Executive Order #13035: Advisory Committee on High Performance Computing and Communications, Information Technology and the Next Generation Internet
- Executive Order #13133: A Safe and Content Rich Internet
- White House Memorandum: Federal Resources for Educational Excellence (FREE) www.ed.gov/free, which becomes the portal to on-line teaching resources across the federal government.

- Migrant Education Technology Grants

- America Links Up, Internet Online Summit
- U.S. Department of Education's Conferences on Improving America's Schools: Institute on Using Technology as a Tool for Education Reform
- U.S. Department of Education Satellite Town Meeting: Ensuring Access to the Internet

- American Association of Colleges for Teacher Education: *The Use of Technology by Schools, Colleges, and Departments of Education*
- The CEO Forum on Education and Technology: *School Technology and Readiness Report: From Pillars to Progress*
- Education Week: *Technology Counts: Schools and Reform in the Information Age*
- President's Committee of Advisors on Science and Technology (PCAST), Panel on Educational Technology: *Report to the President on the Use of Technology to Strengthen K-12 Education in the United States*
- U.S. Department of Education: *America's Technology Literacy Challenge: Using Technology as a Tool for Education Reform*
- U.S. Department of Education: *Parents Guide to the Internet*
- U.S. Department of Education/American Institutes for Research: *Investing in School Technology: Strategies to Meet the Funding Challenge*
- U.S. Department of Education, National Center for Education Statistics: *Advanced Telecommunications in U.S. Private Schools, K-12*, Fall 1995
- U.S. Department of Education, National Center for Education Statistics: *Advanced Telecommunications in U.S. Public Elementary and Secondary Schools*, Fall 1996
- U.S. Department of Education, National Center for Education Statistics: *Distance Education in Higher Education Institutions*
- U.S. Department of Education/SRI International: *Technology and Education Reform: Studies of Education Reform*

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- 1998 Amendments to the Higher Education Act of 1965, P.L. 105-244 (Sec. 410a. Learning Anytime Anywhere Partnerships; Sec. 486. Distance Education Demonstration Programs; Part J- Web-Based Education Commission)
- The Children's Online Privacy Protection Act (COPPA)

President Clinton's Commencement Address at the Massachusetts Institute of Technology: Calls for student technological literacy by the end of the 8th grade and a strengthened commitment to professional development.

- Secretary Riley's Technology Address at the National Press Club: Called for a commitment to eliminating the digital divide.

1998

E-Rate discounts awarded to 25,000 applicants to provide telecommunications services and help more than 500,000 classrooms get wired for the Internet.

- Expert Panel on Educational Technology

- Commission on Online Child Protection (COPA)
- U.S. Working Group on Electronic Commerce

- U.S. Department of Education's Conferences on Improving America's Schools: Institute on Technology Classroom Simulations
- U.S. Department of Education Satellite Town Meeting: Updating Technology, Buildings and Classrooms
- White House Conference on Technology Training for Teachers

- American Library Association/U.S. Department of Education: *The 1998 National Survey of U.S. Public Library Outlet Internet Connectivity*
- The CEO Forum on Education and Technology: *A Tool for Assessing School Technology and Readiness: Focus on Professional Development*
- Education Week: Technology Counts '98: *Putting School Technology to the Test*
- U.S. Department of Commerce: *Falling Through the Net II: New Data on the Digital Divide*
- U.S. Department of Education/American Institutes for Research: *An Educator's Guide to Evaluating The Use of Technology in Schools and Classrooms*
- U.S. Department of Education, National Center for Education Statistics: *Distance Education in Higher Education Institutions: Incidence, Audiences, and Plans to Expand*
- U.S. Department of Education, National Center for Education Statistics: *Internet Access in Public Schools*
- U.S. Department of Education, National Center for Education Statistics: *Technology @ Your Fingertips: A Guide to Implementing Technology Solutions for Education Agencies and Institutions*
- United States General Accounting Office: *School Technology: Five School Districts' Experiences in Funding Technology Programs*

1999

- Executive Order #13133: Working Group on Unlawful Conduct on the Internet
- White House Memorandum: Narrowing the Digital Divide: Creating Opportunities for All Americans in the Digital Age

- Community Technology Centers
- Distance Education Demonstration Program
- Interagency Education Research Initiative
- Learning Anytime Anywhere Partnerships
- Preparing Tomorrow's Teachers to Use Technology

- National Commission on Mathematics and Science Teaching for the 21st Century
- Web-based Education Commission

- Secretary Riley's Third Conference on Educational Technology: Evaluating the Effectiveness of Technology
- U.S. Department of Commerce: Digital Divide Summit
- U.S. Department of Education's Conferences on Improving America's Schools: Institute on Evaluating the Use of Technology to Improve Teaching and Learning
- U.S. Department of Education, Office of Educational Technology: Forum on Technology in Education: Envisioning the Future
- U.S. Department of Education Satellite Town Meeting, The Power of Technology
- The White House Conference on 21st Century Skills for 21st Century Jobs

- Education Week: *Technology Counts '99: Building the Digital Curriculum*
- President's Information Technology Advisory Committee: *Informing Technology Research: Investing in Our Future*
- U.S. Department of Commerce: The Digital Work Force: *Building Infotech Skills at the Speed of Innovation*
- U. S. Department of Commerce: *Falling Through the Net: Defining the Digital Divide*
- U.S. Department of Commerce/New Mexico State University College of Engineering: *Assessment of Technology Infrastructure in Native American Communities*
- U.S. Department of Education: *Technology Literacy Challenge Fund Report to Congress*
- U.S. Department of Education, National Center for Education Statistics: *Distance Education at Postsecondary Education Institutions: 1997-98*
- U.S. Department of Education, National Center for Education Statistics: *Internet Access in Public Schools and Classrooms: 1994-98*
- U.S. General Accounting Office: *Federal Funding for Schools and Libraries*
- U.S. Working Group on Electronic Commerce: *Towards Digital eQuality*

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2000

President Clinton's New Markets Tour: From Digital Divide to Digital Opportunity. In addition to promoting digital opportunities in new markets across the country, President Clinton encourages digital opportunities for Americans with disabilities.

- National Academy of Sciences and National Academy of Engineering: Improving Learning with Technology
- National Academy of Sciences: Tools and Strategies for Protecting Kids for Pornography and Their Applicability to Other Inappropriate Internet Content
- Secretary Riley's Fourth Conference on Educational Technology: Measuring Impacts and Shaping the Future
- U.S. Department of Education's Conferences on Improving America's Schools: Institute on Learning to Teach with Technology
- U.S. Department of Education Regional Conferences 2000: Guidelines for Evaluating Technology in Education
- U.S. Department of Education Satellite Town Meeting: Technology and Buildings for a New Century
- U.S. Department of Education: The Bridge Builders Conference: Over the Digital Divide

- **The CEO Forum on Education and Technology:** ***The Power of Learning: Integrating Digital Content - School Technology and Readiness Report***
- **The CEO Forum on Education and Technology:** ***Teacher Preparation STaR Chart: A Self-Assessment Tool for Colleges of Education***
- **Commission on Online Child Protection:** ***Final Report of the COPA Commission***
- **International Society for Technology in Education: National Educational Technology Standards for Students:** ***Connecting Curriculum and Technology***
- **International Society for Technology in Education:** ***National Educational Technology Standards for Teachers***
- **The National Commission on Mathematics and Science Teaching in the 21st Century:** ***Before It's Too Late***
- **President's Working Group on Unlawful Conduct on the Internet: The Electronic Frontier:** ***The Challenge of Unlawful Conduct Involving the Use of the Internet***
- **U.S. Department of Commerce:** ***Falling Through the Net: Toward Digital Inclusion***
- **U.S. Department of Education/Grove Consultants International/Institute for the Future:** ***Mapping the Educational Technology Horizon***
- **U.S. Department of Education, National Center for Education Statistics:** ***Computer and Internet Access in Private Schools and Classrooms: 1995 and 1998***
- **U.S. Department of Education, National Center for Education Statistics:** ***Internet Access in U.S. Public Schools and Classrooms: 1994-1999***
- **U.S. Department of Education, National Center for Education Statistics: Teachers' Tools for the 21st Century:** ***A Report on Teachers' Use of Technology***
- **U.S. Department of Education, National Center for Education Statistics:** ***Teacher Use of Computers and the Internet in Public Schools***
- **U.S. Department of Education, National Center for Education Statistics:** ***What are the Barriers to the Use of Advanced Telecommunications for Students with Disabilities in Public Schools?***
- **U.S. Department of Education/Urban Institute: E-Rate and the Digital Divide:** ***A Preliminary Analysis from the Integrated Studies of Educational Technology***
- **Web-based Education Commission:** ***The Power of the Internet for Learning: Moving from Promise to Practice***

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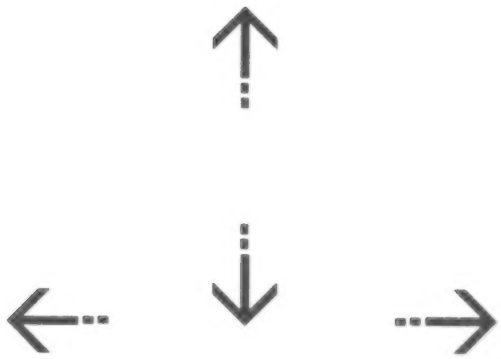

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